DOCUMENT RESUME

ED 099 473 CE 002 543

TITLE Industrial Arts--Woods and Wood Technology: A Curriculum Guide for Intermediate and Secondary Level Programs.

INSTITUTION Missouri Council for Industrial Arts Education.; Missouri State Dept. of Education, Jefferson City.

PUB DATE 74

NOTE 174p.; For related documents, see CE 002 544 and 545

EDRS PRICE MF-$0.75 HC-$7.80 PLUS POSTAGE

DESCRIPTORS Construction (Process); Course Content; Course Objectives; *Curriculum Guides; *Industrial Arts; *Industrial Education; Junior High Schools; *Production Techniques; Resource Guides; Secondary Education; Units of Study (Subject Fields); *Woodworking

IDENTIFIERS *Missouri

ABSTRACT

The curriculum outline is designed to aid the instructor in developing a more complete course of study in woods and wood technology for intermediate and secondary school students. The guide is introduced by a discussion of objectives fundamental to a sound program of industrial arts education, followed by an outline and objectives for the content area of the course. The content is presented with reference to four levels of instruction. An introductory section, Woods and Wood Technology, presents the course content in 13 areas, with suggested student activities and teacher techniques. Seven selected topics make up the major portion of the document and where applicable include techniques, processes, and products for the industrial arts woodworking curriculum. These seven content areas are: wood lamination; PEG (polyethylene glycol) diffusion; wood flour and/or particle molding; the production product of industry; wood plastic composition; residential construction; and wood structure, properties, and identification. Each content area includes lists of resource materials. The volume concludes with a resource guide including textbooks and references, visual aids and sources, other resource materials, an equipment, and furniture list, and charts for PEG soaking and drying schedules, the automatic drying chamber drying record, and wood plastic composition. (NH)

ED 099473

INDUSTRIAL ARTS

WOODS AND WOOD TECHNOLOGY

A CURRICULUM GUIDE FOR INTERMEDIATE AND SECONDARY LEVEL PROGRAMS

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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CE 002 543

1974 EDITION

MISSOURI STATE DEPARTMENT OF EDUCATION

ARTHUR MALLORY

COMMISSIONER OF EDUCATION

JEFFERSON CITY, MISSOURI

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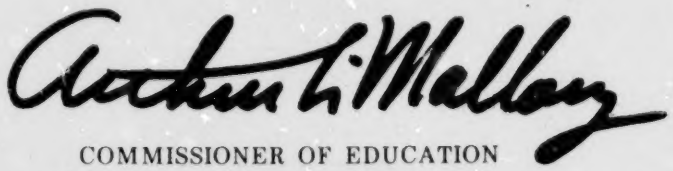
FOREWORD

This curriculum guide was formulated by a committee under the auspices of the Missouri Council for Industrial Arts Education. In preparing and publishing the curriculum guide, the appointed committee, cooperating with supervisory personnel of the State Department of Education, worked toward the goal of initiating and improving woods and wood technology instruction in Missouri.

The guide is designed to aid teachers in establishing course objectives and course content, as well as planning teaching methods and evaluation procedure. It is intended that the individuals and groups that review and use this publication will find the suggested content, activities and teaching aids presented in a manner that will enable the user to adopt or adapt them in a meaningful manner.

The background experiences of the members of the woods and wood technology committee included a variety of teaching experiences and educational qualifications so necessary in formulating a functional publication of this type. The donation of time and effort by committee members indicates the importance they place on woods and wood technology in industrial arts and in the overall education program. Special recognition also goes to the state and national professional industrial education organizations whose materials were reviewed.



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The industrial education department heads, wood technology and professional educators of the state universities and the many industrial arts educators in the public school districts deserve a special note of thanks for reading the first draft of the guide. Their comments, suggestions and additions have been included in the final assembled guide.

INTRODUCTORY COMMENTS FROM THE WOODS CURRICULUM COMMITTEE

It is the opinion of the Woods Curriculum Committee that industrial arts woodworking in Missouri has primarily and traditionally been directed toward only *one* area of the vast forest products industries, that of furniture and cabinet construction. Fabrication of large products such as furniture or cabinet work is expensive, time consuming and has limited the viewpoint of the general education industrial arts woodworking student and his investigations into other equally important areas of forest product industries.

The continued production of finished products in the various process areas is still the best method to motivate and hold the interest of our woodworking students. A comprehensive approach is recommended which will necessitate the construction of smaller products but will permit investigations in at least three or more of the seven process areas listed in the woods curriculum guide. Conventional manipulative woodworking activities have not been removed in this approach but are included in their proper perspective according to the level of instruction and units covered.

Related information, sequence studies and drawings in each of the process areas have been included in the curriculum guide giving suggested methods, techniques, procedures, equipment and supply sources. This guide will aid the teacher in broadening the scope of his or her industrial arts woodworking curriculum.

Several of the process areas listed in the guide could lend themselves very well to the material-science approach rather than the product oriented approach. It is the committee's opinion that industrial arts woodworking should continue to have a product orientation, especially in Levels I-III.

Each of the areas included in the guide has a complete set of equipment drawings to enable the industrial arts teacher and/or students in Levels III and IV to fabricate and assemble the process equipment for use in the industrial arts laboratory. Level III and IV students should welcome the opportunity to re-design and/or construct equipment useful to their class activities. In the teacher preparation programs of the undergraduate, selected process equipment may be constructed in a college or university special problems or investigation type course. For the postgraduate, it is suggested that the teacher take advantage of in-service type workshops being held to familiarize teachers with the various process areas covered in the guide.

Equipment can presently be purchased for all of the process areas with the exception of the Wood Plastic Composition (WPC) unit. School equipment and machine suppliers have indicated that this and other specialized pieces of equipment are now being developed and should be available in the near future. Adaptation of existing equipment can make this a worthwhile experience for teachers and students.

The unit method presently being used to teach industrial arts woodworking (furniture making) can still be elected by Level III or IV students to continue his educational manipulative experiences and investigations in greater depth. It is also possible to add one or more of the other process areas to enrich the traditional approach in the teaching of industrial arts woodworking.

The committee urges you to carefully read and study the entire guide and weigh the advantage of this "general shop" type of approach to the teaching of industrial arts woodworking, particularly in Levels I and II.

ACKNOWLEDGMENTS

Dr. F. Milton Miller, Associate Professor of Industrial Education, University of Missouri-Columbia, assisted in organizing and editing the materials for the publication.

Southwest Missouri State University Industrial Education students working on their Bachelor of Science and/or Bachelor of Science in Education degrees who developed the 'new and used' ideas in the various process areas; their names are noted on the respective product drawings.

Dr. Robert Beach of the SMSU Industrial Education faculty who served as advisor to Mr. John Dryton in his analysis of the product in the Production Product of Industry process area.

Mr. John Dryton and Mr. Gene Haggard, Industrial Technology SMSU students, for their work and skill involved in developing the many drawings and charts.

Dr. Orin Robinson, head of the Industrial Education Department at SMSU, for his approval of funds to develop the process areas, prototypes and printed materials to publicize the woods curriculum guide prior to publication.

Dr. Robert Beach, as chairman of and the Southwest Missouri District Industrial Education Awards Program for sponsoring the many pictures, slides and tapes used in and for the guide.

Mr. John E. Wylie, Missouri Assistant State Forester, and Mr. Jim Sorenson, Forester, for their contribution to the Wood Structure, Properties and Identification process area.

Mr. Eugene Brightwell of the State Department of Education who originated this curriculum guide project and saw the need for improvement in the area of woods and wood technology in our public schools.

Mrs. Marie Vaughn, IED, SMSU departmental secretary, Mrs. Margaret Koppenaal and the other clerical staff members who read, corrected, typed and readied the guide material for publication.

Mr. Olan Oatman of the IED, SMSU faculty for photographs used in this publication.

To the industrial education department heads, wood technology and professional educators of the state universities and the many industrial arts educators in the public school districts, a special note of thanks for reading the first draft of the guide. Their comments, suggestions and additions have been included in the final assembled guide.

POINT OF VIEW AND OBJECTIVES

A principal purpose of American education is to assist each individual in his development as a productive member of society. The achievement of this purpose enables him to provide for his basic needs, to produce more than he consumes, and to contribute more than he receives. It also involves the development of ideals and goals, the acceptance of social responsibility, and the acquisition of desirable character traits.

Behavorial changes within the individual are effected through experiences and the interpretation of these experiences. The experiences provided by the school permit one to acquire the skills and knowledges which allow the individual to develop to his maximum potential with profit to himself and society. The learner's interpretation of these educational experiences provide for the further development of desirable character traits which lead to the wise application of the acquired skills and knowledges.

Industrial arts contributes to the purpose of American education by aiding individuals as they gain an understanding of their industrial-technological environment. In order that each individual may understand and learn to exercise some control over this environment, experiences in industrial arts must be an integral part of the overall educational program for all students, both boys and girls, and should be available at all grade levels. The importance of this experience is recognized in Missouri where credit in the practical arts, which includes industrial arts, is a secondary school graduation requirement.

Industrial arts education provides an opportunity for individuals to participate in direct experiences involving industrial skills and processes which foster an awareness of industry in American culture. These experiences are concrete, meaningful, and educational as they aid the individual in understanding abstract ideas. These experiences provide opportunity for an individual to apply mathematics, science, art, language arts, and other school subjects in purposeful situations.

Through the application of grouping and special instructional techniques, industrial arts in the secondary school can be organized to meet the needs of students of varying abilities. Individuals expecting to enter professional occupations as well as future industrial workers should benefit from industrial arts experiences. The need for industrial arts instruction has little relationship to the economic status of the student. Every person must be aware of and familiar with the concepts taught in industrial arts education if he is to live effectively in our industrial society.

Industrial arts education aids in the discovery and development of personal interests, aptitudes, creative thinking and technical abilities. Responsible and resourceful actions and judgements are matured through problem solving and self-expression in an environment related to industry. The future scientist or engineer may learn to solve technical problems, and the future technician or craftsman may devlop skills and related understandings in industrial arts courses.

Realistic objectives, clearly stated, are essential to a sound program of industrial arts education. The following statements of purpose are fundamental to quality industrial arts education as it provides opportunities for students to:

Develop an insight and understanding of tools, machines, materials, and processes as they relate to the production and servicing aspects of industry.

The field of industrial arts education is concerned with the study of materials and processes of industry and the creative use of design. Students of industrial arts education have an opportunity to gain a better understanding of mass production, automation, and other industrial methods if they actively participate in meaningful experiences dealing with the manufacturing of consumer goods, utilization and generation of energy as well as the servicing, testing, and repairing of industrial products.

Discover and develop abilities, aptitudes, and interests related to the technical pursuits and applied sciences.

Opportunities for students to have experiences which assist in the discovery of abilities and to develop their potentialities to the fullest is essential to the basic education of all youth. Allowance for differences of abilities, interests, and needs should be incorporated into the curriculum offerings so the student can better assess his abilities and interests for making an occupational choice, understanding his environment, and preparing himself to meet the changing demands of a technological society.

Develop basic skills in the safe and proper use of industrial materials, tools, machines, and processes.

Students are provided with experiences which help them develop basic skills relevant to industrial production; and servicing through these experiences, students gain a basis for making occupational choices. In addition, the skills provide a basis for a specialized occupational preparation. Many workers of the future will be required to train and retrain for different occupations during their lifetime. Fundamental skills and knowledge in diversified areas is most essential if this retraining is to be accomplished in an efficient manner.

Develop problem-solving and creative abilities relating to the tools, machines, materials, processes, and products of industry.

The industrial arts education program provides opportunities for solving various types of technical problems through experimentation and research as well as project planning and construction. The industrial arts laboratory setting provides an environment which makes possible a concrete, understandable approach to teaching problem-solving and critical thinking. Problem-solving in industrial arts education involves creative thinking and provides experiences which allow students to find solutions to problems and to evaluate the effectiveness of these solutions.

A brief overview and specific applicable objectives for Levels I-IV may be found on pages 1-3, immediately preceding the Student Activities and Teacher Techniques section.

*Taken from the *Handbook for Industrial Arts Education*, Missouri State Department of Education, 1969.

Legislative Consideration

The definition of vocational education in Federal legislation was supplemented to include industrial arts education in 1973. The Federal Register, Vol. 38 No. 244-Wednesday, Nov. 21, 1973, carries the rules and regulations for this legislation. More specifically these rules and regulations indicate that industrial arts educational programs shall be designed to:

"(i) Assist individuals in making of informed and meaningful occupational choices.

(ii) Prepare individuals for enrollment in advanced or highly skilled vocational and technical educational programs."

Both of these objectives are included in the previously stated objectives quoted from the *Handbook for Industrial Arts Education*.

INTRODUCTION TO WOODS AND WOOD TECHNOLOGY

Wood is man's most intimate material. He is in daily contact with it in some form throughout his life. Wood is the major material in his home, his furniture, his newspapers, magazines and books, and in more than 5,000 other products made for his necessities, comforts and pleasures.

Wood in all forms is an intriguing material. All who work with it are constantly challenged by its many properties, uses and vast potentials; they are stimulated by wood's beauty, warmth and other characteristics that many materials so often imitate, but never equal.

Wood is not a material of the past. It actively serves the present, and offers hundreds of untapped uses for the future. Only by proper instruction in both the classroom and laboratory manipulative experiences in the basic properties and current uses of wood can the importance and potentialities of wood be recognized. Woodworking classes should offer sound, fundamental knowledge that is applicable to modern living.

The systematic study of industry and technology is an essential part of the education of all youth from the elementary school through college. At each educational level, the subject is organized to take advantage of the interest and needs of the students.

The various levels, I-IV, referred to in this woodworking guide has reference to the re-alignment of industrial arts curriculums developed by the various Curriculum Development Committees. A brief summary of the chart found in the bulletin *Handbook for Industrial Arts Education*, Missouri State Department of Education, p. 2-2. 1969, follows:

Level I, exploratory industrial arts (general shop), should be required in the middle and/or junior high school. The course is exploratory in nature and provides an opportunity for all students to become oriented to a number of content areas in industrial arts.

Level II courses are designed as elective education beginning at the ninth grade and are built upon the exploratory experiences provided at Level I. These courses promote unique interests, needs and abilities of individuals rather than those common to all.

Level III courses are advanced technical courses designed to provide experiences in a rather specialized phase of a single content area of industrial arts and must, or should be preceded by a Level II course in the same content area. Although these courses are quite specialized, their primary purpose is to meet the more unique interest and needs of the individual and not to prepare him for a specific occupation.

Level IV courses should meet the specialized needs of youth. The strength of industrial arts offerings at this level is in its adaptability to new conditions and new circumstances.

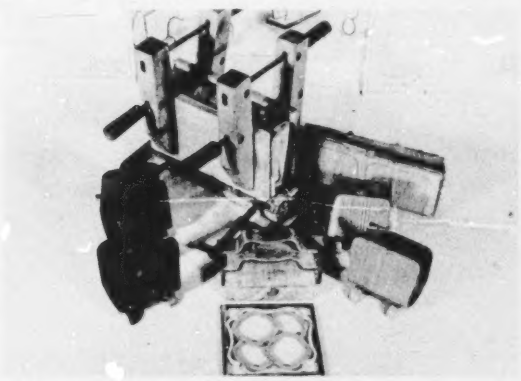
The seven selected process or content areas of woods and wood technology that made up the curriculum guide are presented in a brief overview on the following pages and illustrate applicable techniques, processes and products for your industrial arts woodworking curriculum.

WOODS AND WOOD TECHNOLOGY: TECHNIQUES, PROCESSES AND PRODUCTS

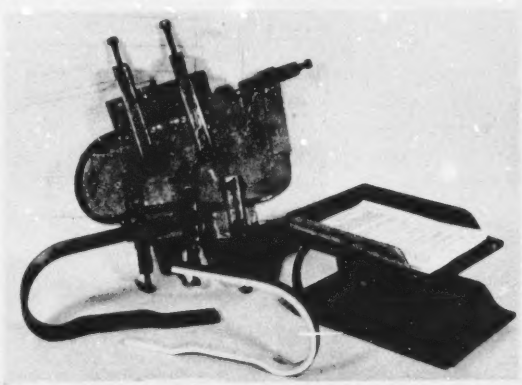
I. WOOD LAMINATION

Wood lamination is not a new process, however many of the applications of the current techniques of laminations are relatively recent in origin. Stacked wood veneers are capable of being bent and glued to conform to a surface which has a marked curvature as illustrated in Figure 1-1. Laminates, flat or curved, are fabricated by sandwiching adhesive covered veneers in a mold or form and bonded under pressure. Laminates are under internal stress at all times and like solid wood reacts to humidity in an expanding or contracting movement, therefore making it necessary to design the form, mold or caul to the final equilibrium moisture content shape of the finished product.

Lamination is important to the industrial arts woodworking student because of the design possibilities it offers. The process permits designs which are lighter in weight, exceptionally strong and much less wasteful wood than products constructed from solid wood. Lamination provides an opportunity for the student to improve an important natural material without sacrificing its inherent beauty and without undue waste of materials.



Laminated Napkin Holder with Jig and Fixtures [Fig. 1]



In-Out Tray with Jig and Fixtures [Fig. 2]

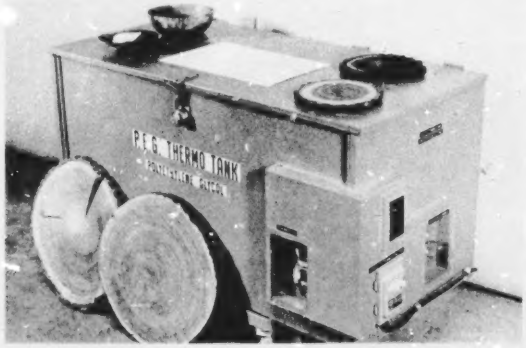
The individual industrial arts woodworking student will find the possibilities of wood laminations fascinating. The laminated napkin holder (Fig. 1) has been selected as a product, or as a guide for products to be developed in Level I. The in-out tray (Fig. 2) has been developed to challenge the Level II industrial arts student in his first year of woodworking. The in-out tray will introduce the student to a more complex product than the napkin holder and combines laminated components with solid wood construction. Level III and IV woodworking students will discover the area of wood laminations to be a challenge to their creative abilities and a continued development of their manipulative skills.

II. PEG DIFFUSION

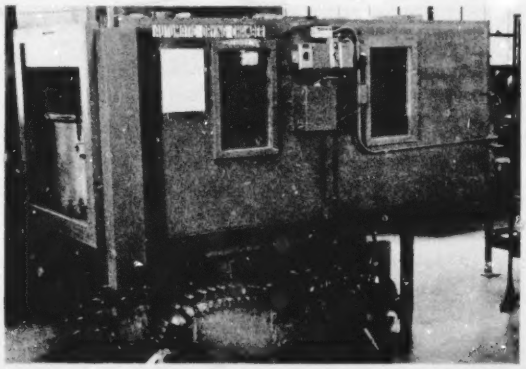
PEG (polyethylene glycol) treated wood is permanently kept from shrinking, swelling or warping regardless of the atmospheric humidity to which the finished product will be subjected. PEG, a white waxlike material developed by Forest Products Laboratory at Madison, Wisconsin, when properly diffused into individual wood cell lumens and walls will have a bulking effect that tends to stabilize wood in use. This treatment allows various species of wood with different specific gravities to be combined in a single product.

Green wood or wood with a moisture content above the fiber saturation point, treated in a 30-50% water solution of PEG and dried to equilibrium moisture content, can be machined, sanded and finished into aesthetic or functional products by industrial arts students in Levels I and II. Continued research, development and construction of treatment and drying equipment is recommended for woodworking students in levels III and IV.

Elevated temperatures of the PEG solution in a Thermo Tank (Fig. 3) is not absolutely necessary but will shorten the long diffusion time required by the cold or room temperature method. Drying of PEG treated woods can be accomplished under rather drastic heat conditions in a kiln or drying chamber. The Automatic Drying Chamber (Fig. 4) can cut down on the drying time enabling woodworking students to continue their hand or machine laboratory operations without the long delay required when using the room temperature drying method.



PEG Diffusion Process [Fig. 3]



Drying Unit [Fig. 4]

The PEG diffusion process opens up a new field of conservation and marketability of waste tree parts that can be developed into a variety of products limited only by the imagination and ingenuity of woodworking industrial arts students.

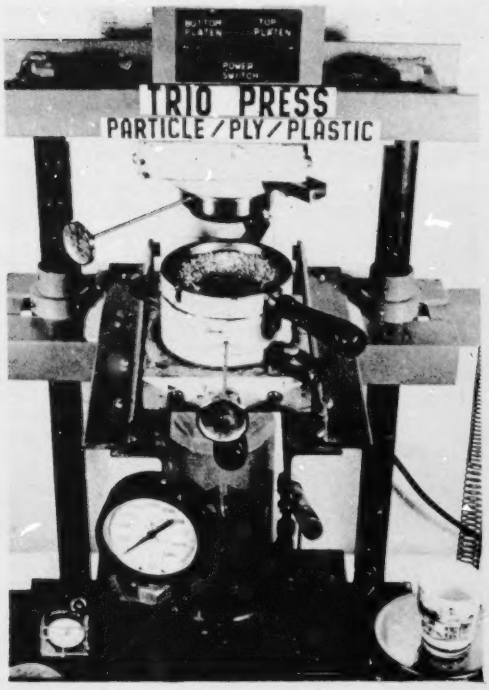
III. WOOD FLOUR AND/OR PARTICLE MOLDING

Particle, ply and plastic molding in the Trio Press will give the woodworking student an opportunity to produce a product (molded wood), component (plastic disc) or fabricate materials (ply or laminated wood) to use in other laboratory experiences.

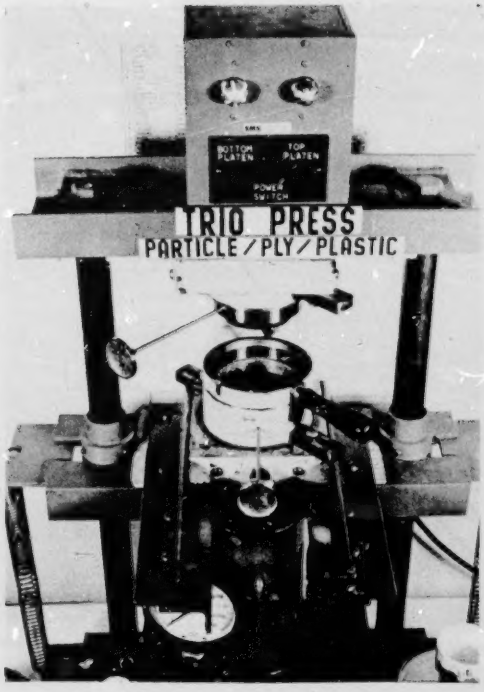
Current processes of molding wood consist of mixing wood particles with thermosetting synthetic resin adhesives, depositing the mixture into the cavity of a heated mold (Fig. 5) and applying pressure hydraulically until the curing of the resin is completed. The mold is then opened and the molded product can be removed in a nearly finished condition. (Fig. 6)

It is recommended that the Level I student not only perform wood particle molding operations, but that he be permitted to prepare wood particle-resin molding mixtures, weigh out molding charges and beauty moldings by means of various finishing operations. Level II woodworking students could, in addition to the molding operations, design a mold, fabricate a pattern and cast an aluminum mold which will produce an item displaying his original design. Level III and IV students should have the skills and ability to construct the Trio Press and conduct further research with the process of molding wood particles.

In addition to molding wood particle coasters or other individually designed products the Level I student can utilize scrap thermoplastic pieces and produce a disc in the test die to be used in fabricating a product for the plastics area. Plywood or laminated blanks can be used in fabricating switch plate covers as illustrated. (Fig. III-2)



Wood Particle Coaster Molding Charge [Fig. 5]



Molded Wood Particle Coaster [Fig. 6]

IV. PRODUCTION PRODUCT OF INDUSTRY

The production product of industry is possibly better known in industrial arts curriculums as Mass Production: Principles, Applications and Operations.

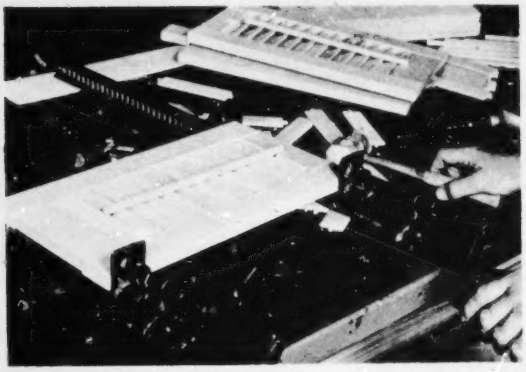
A better understanding of industry should be one of the objectives your students will encounter in his woodworking courses. Industrial arts students should have an opportunity to participate in simulated situations which will allow them to experience social and technical problems similar to those they will meet in adult life. The production product can be used for skill development, will involve problem solving, creativity and serve as a unifying experience for developing a comprehensive conception of industrial systems.

Mass production can become an extremely complicated and time consuming study. However, it is recommended that it be just one of the several areas developed and utilized in woodworking courses. Informational content in the form of class discussions, reports, homework and committee activities should prepare the class for a 'production run'.

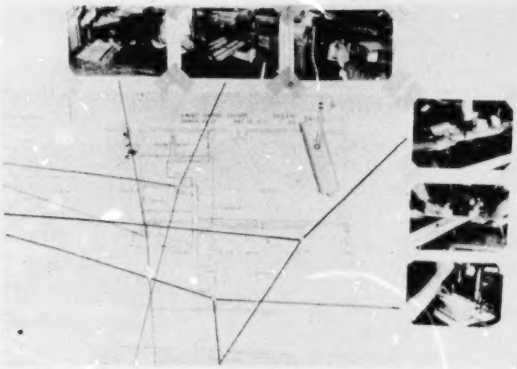
The product, interior window shutters (Fig. 7), has been redesigned and process analyzed (Fig. 8) to give students of a Level II woodworking class an opportunity to plan, redesign, organize, set-up and produce a product. It is recommended that this unit of study be instituted near the end of the regular school year.

It is anticipated that the production product will be attempted by the class only after the students have developed an appreciation of wood, its properties and potentials for use in our society. To provide the most effective learning situation the students involved should have gained a satisfactory level of skill with hand and machine tools and an understanding and appreciation of processes needed for a successful completion of the product selected.

The drawing and procedure for developing this product has been set up in a conventional 'plans and steps type of industrial arts project'. In order to note the difference between a 'project plan and



Assembly of an Interior Window Shutter [Fig. 7]



Flow Diagram of Louver Component for Window Shutter [Fig. 8]

steps' and the procedure used by a large wood products industry, an industrial assembly of sheets has been worked out for your information, study and use.

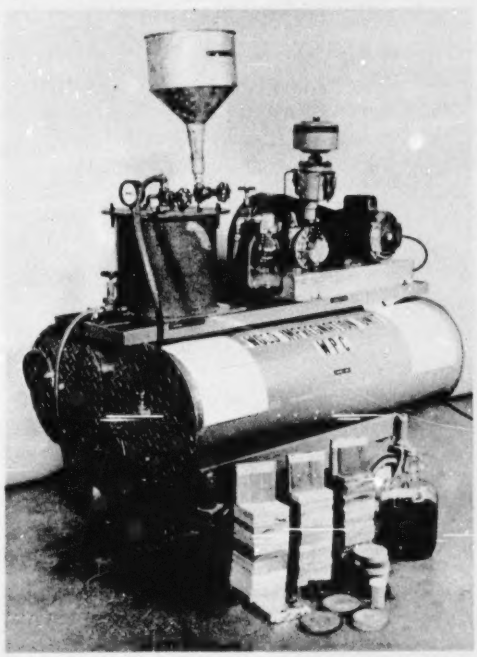
Adaptation of the design; jigs and fixtures for production and assembly; areas, machines and processes to be used; assignment of machine operations; inspection and control personnel are just a few of the many phases of industrial production units to be worked out by woodworking students in Level III and IV.

V. WOOD PLASTIC COMPOSITION (WPC)

Wood impregnation by the Wood Plastic Composition (WPC) upgrades wood as a structural material by increasing its strength, hardness, abrasion resistance, durability and dimensional stability. The improved wood has resistance to mildew, fungus, insect attack and can be made fire retardant by the incorporation of appropriate chemicals. WPC modified wood accentuates the grain pattern, especially when dyes are included in the liquid monomer mixture. No surface coating is required on the impregnated wood but finish can be applied if desired for special decorative effects.

Modified-wood-plastic materials are compatible and adaptable to contemporary industrial arts curriculums. The WPC Wood Impregnation Unit (Fig. 9) can be fabricated by Level III or IV industrial arts students to impregnate wood in the industrial arts laboratory. This type of facility would provide the industrial arts woodworking program with a replication of a realistic, contemporary industrial process and also provide a less expensive source of modified wood for products produced by woodworking students in Levels I and II.

This process of wood modification is also known as Methacrylated Wood. This term refers to the composite structure formed by impregnating the lumens of wood with monomer, methyl methacrylate (the polymerized form is better known as Lucite) and hardening the plastic monomers. Two processes for bringing about the polymerization of methyl methacrylate in wood are in commercial use today. The first method is used by industries such as ARCO Chemical Company of Philadelphia, Pa., manufacturers of 'Perma Grain' wood-plastic composite flooring. This company hardens the liquid



WPC Wood Impregnation Unit [Fig. 9]

plastic by nuclear radiation. The second method uses a chemical initiator. The preferred initiator or catalyst is Vazo; it is efficient and inert to degradation by chemicals in the wood. The Vazo powder is disolved in the monomer just before impregnating the wood.

The chemically initiated methacrylation process is adaptable to industrial arts facilities and involves the following four steps:

1. Evacuating the air from the pores or lumens of kiln-dried wood.
2. Immersing the evacuated wood in methyl methacrylate containing a chemical initiator.
3. Releasing the vacuum to impregnate the wood with monomer.
4. Polymerizing the monomer within the wood by gentle heating.

The modified wood produced by this process is twice as hard as the initial wood. Density and specific gravity will double, as well as sheer strength both parallel and perpendicular to the grain. An additional feature of WPC materials is built in, no finish is required on the completed product! Suggested broad area uses for industrial arts products or components of products constructed from WPC or methacrylated wood are: handles, furniture, building materials, musical instruments, marine construction and sporting equipment. Industrial arts woodworking students through all levels I-IV will find this improved wood an exciting medium to work with.

VI. RESIDENTIAL CONSTRUCTION

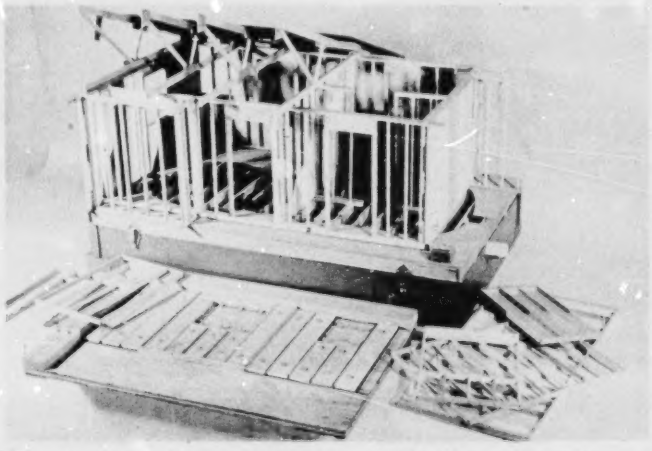
Residential construction, with scaled-down models, should be a part of the industrial arts woodworking curriculum in Levels II and III.

Models of 'light' construction, adaptable to woodworking classes, could include homes, farm structures, small churches, schools, commercial and industrial buildings. Homes or residential buildings, one of lumber's largest markets, amounts to more than a million houses a year. Of these, four out of five are of wood construction, each averaging 10,000 board feet of lumber.

It is extremely important that every IA student be given an opportunity to acqure some knowledge of good home design and basic building construction methods. This area of woodworking will enable him to buy or build wisely, thus solving many building problems even though he may not enter the building industries. Residential construction model building should not be vocationally oriented, however students will have learned concepts of a large phase of the wood industry.

The house plans selected to aid in the residential construction unit has been divided into 4 sections as noted on the floor and foundation drawings. This method will allow a team of students to construct a section of the house at varied times during the school year. After all sections have been completed, the four sections could be moved into the proper position showing the assembled structure in its proper perspective.

The recommended scale is 1½ inch equals 1 foot and was used on the



Scaled-Down Portion of Residential Construction Model with Wall Frame Jig [Fig. 10]

teaching model shown in figure 10. Also shown in the illustration is a wall frame jig, a construction technique that lends itself to the mass-production, assembly-line basis in factories. This concept, modular construction, is one of the latest steps away from the traditional method of building homes; it is more efficient and less costly. Other techniques in the building construction industries, materials and processes can be researched and developed by Level IV industrial arts woodworking students.

VII. WOOD STRUCTURE, PROPERTIES AND IDENTIFICATION

A study of wood structure, its properties and methods of identification is essential to our IA woodworking students to aid in their selection of appropriate materials for product development.

Modern wood industries devote considerable time to analysis, evaluation, and selection of materials appropriate to a given product's physical, mechanical, and environmental requirements. Our industrial arts classrooms and laboratories should be areas where research and experimentation can be applied to better understand the complex structures of the basic raw material we use, wood.

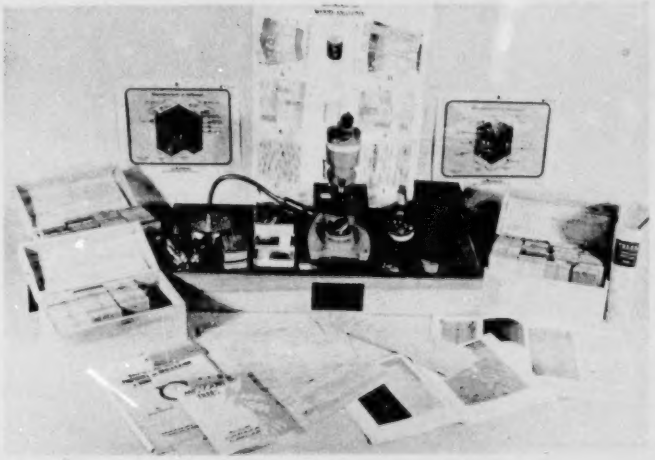
Wood is so commonplace that we take it for granted. The solid piece of wood used in our products, when viewed under a microscope, becomes intricate arrangements of strong, though tiny cells seen as either ring porous, diffuse porous or non-porous structures. This network of cells may also be seen if the surface or edge is trimmed with a sharp knife or single edge razor blade and either viewed with the unaided eye or with a 10x hand lens.

The majority of wood cells are long and thin with tapered ends, rather like hollow toothpicks. Fibers, one type of cell in hardwoods, are actually very minute, approximately 1/25 of an inch in length. Tracheids, a type of cell in softwoods are about 1/8 of an inch in length or about 4 millimeters. Most hard and softwood cells are tapered in shape and have their length dimension nearly parallel to the long direction of the tree stem. Whether we see the large or small dimension of the cell depends on how the wood is cut.

Generally, for structural purposes, woods are divided into two groups, hardwoods and softwoods. Softwoods consist of the cone-bearing trees which have needles or scalelike leaves such as the pines, spruces and firs. Woods from this group are considered non-porous. Hardwoods consists of broad-leaved trees which usually drop their leaves in the fall. Woods from this group have diffuse or ring porous cell structures. These include the oaks, ashes, birches, maples and many others commonly used in our woodworking courses. The separation into these two groups does not mean that all hardwoods have harder wood than the softwoods but it is a convenient way to divide woods based on their cell structure.

An excellent manual has been prepared by Forest Products Laboratory of the Forest Service, U.S. Department of Agriculture, entitled, Classroom Demonstrations of Wood Properties. This manual will aid woodworking teachers in demonstrating some of the properties of wood and how these propertes relate to the cellular structure of wood. These demonstrations can be used in Levels I-IV and can be expanded to meet the needs of particular students.

The Wood Study Center shown in Fig. 11 illustrates a variety of materials to aid students in woodworking courses to better understand the basic materials used in their laboratory manipulative experiences.



Wood Study Center [Fig. 11]

OPPORTUNITIES UNLIMITED *

The forest products industries, oldest in years but youngest in opportunities, offers prestige and profit to those who choose this exciting field for their future careers. Major career areas in the forest products industries are: forestry, manufacturing, wood sciences and technology, research and development, marketing and information and communications. Each area has multiple fields for specialists in technical and non-technical activities. Private industry is the largest employer of forest products technologist. There are also many career opportunities in the wood research and forest utilization programs of federal and state agencies.

The construction industry, largest lumber consumer, is open for men and women trained in designing and fabricating wood. There are also fine career opportunities in the teaching profession. Energetic students who choose careers in the forest products industries will find a broad field with multiple opportunities and only limited competition for top positions.

Wood industries are ever mindful that trees are a renewable resource and are consistently expanding their scientific efforts in growing timber as a crop and in developing more and wiser uses of each tree harvested. this foresight assures an endless supply of raw materials with which to fill demands for wood products. These industries enjoy a stability that justifies their investments of billions of dollars in land, equipment, and selection and training of employees.

Activities in the wood fields present a challenge and fulfillment. There are no dull moments for technical workers in the forest product industries. They enjoy sights and sounds in the forest, mills and plants. They find thrills and excitement all the way from tiny seedlings growing tomorrow's timber crops to giant wood trusses or arches in a modern timber building.

This curriculum guide has been organized to aid the woodworking teacher in developing a more complete course of study and presenting a more challenging woodworking program for intermediate and secondary school students in the state of Missouri. Each teacher using this guide should make adaptations to meet his or her teaching conditions found in the laboratory and/or classroom facilities.

**Wood Industry Careers.* National Forest Products Association, 1619 Massachusetts, N.W., Washington, D.C. 20036.

LEVELS INTRODUCTION AND SPECIFIC OBJECTIVES

Level I - Exploring Woods and Wood Technology

In exploratory industrial arts (general shop), emphasis is placed on breadth of experience rather than depth; therefore, experiences should be provided in as many basic technical areas as possible.

All students should experience at least two, and if possible three, of the listed wood process areas during his or her general shop course. If the school enrollment justifies only one industrial arts facility it would be necessary to equip the facility with the tools and equipment essential to conduct an exploratory program in all content areas.

Specific applicable level objectives to support the earlier stated Point of View and Objectives are:

To develop an interest in wood product industries.
To develop hand and/or power-tool and machine-tool skills and recognize quality workmanship.
To develop safe working habits.
To develop an appreciation of good design and how to select industrial products wisely.
To develop an orderly procedure in fabricating wood products.
To explore the occupational opportunities of the woodworking industries.

Level II - Wood Technology

While the content and experiences at Level I are designed as general education that provides common learnings desirable for all, Level II courses are designed as elective education beginning at the ninth grade and are built upon the exploratory experiences provided at Level I. Level II courses promote unique interests, needs and abilities of individuals rather than those common to all.

All students should experience at least four, and if possible five, of the listed wood process areas. The course content area is arranged so that if a process area is repeated the suggested content and product will justify the repetition.

Specific applicable objectives to support the earlier stated Point of View and Objectives are:

To provide basic work experiences which are applicable to the woodworking industries.
To develop an awareness of the vast forest product industries.
To develop the students ability to use and care for the common hand and power woodworking tools and machinery.
To develop ability in the areas of designing and planning.
To develop desirable safe working habits and practices.
To explore the occupational opportunities of the woodworking industries.

Level III - Advanced Wood Technology

Level III courses are advanced technical courses designed to provide experiences in a rather specialized phase of a single content area. This level is not to be just an extension or continuation of competencies developed at Level II, but should provide an opportunity for the study of new phases related to the content experienced at Level II. The primary purpose should be to meet the more unique interest and needs of the individual and not to prepare him for a specific occupation.

Specific applicable objectives to support the earlier stated Point of View and Objectives are:

To provide occupation information about the specialized wood product industries.
To develop additional skills in the extended and specialized uses of power and hand tools.
To provide knowledge of current industrial processes and materials used in the wood product industries.
To provide a study of construction techniques applicable to a chosen wood product industry.

Level IV - Specialized Wood Technology

Recognizing that the role of industrial arts at this level is to meet the specialized needs of youth, it is not logical to expect that a standardized program could be proposed that would be equally effective in all senior high schools. The strength of industrial arts offerings at this level is its diversity and its adaptability to new conditions and new circumstances. Decisions regarding specific content organization, methodology as well as the nature of the learning activities are dependent upon the needs, abilities, and interests that characterize a given group of students to be served. The following suggestions are typical of those that may be considered after a study of student needs, interests, and abilities has been made.

A specialized course which would deal primarily with research and experimentation related to materials and processes could be established for students who are seeking greater understanding and application of the principles and concepts of the physical sciences and mathematics.

While the nature of an industrial arts program is such that a great deal of individual and small group instruction is undertaken, the distinct and separate needs of both the slow and rapid learner are less likely to be met in classes where the range of ability is too broad. Separate classes for the slow and rapid learners are desirable to supplement the basic program in a school.

Cooperative experiences can be designed between industrial arts and other subjects such as: mathematics, science, and art to provide opportunities to apply knowledge gained through these other courses.

Another type of class for technical instruction, but not restricted to the gifted student, could be designed for those preparing for future careers in a technologically oriented area such as engineering.

Many students with semi-skilled occupational interests are deprived of an opportunity for specific training due to the lack of an appropriate program. A specialized course might be organized that

would give a greater amount of attention to skill development and work orientation than the typical industrial arts courses given.

Courses designed especially to contribute to the development of leisure time interests of youth and adults may be organized.

Specific applicable objectives to support the earlier stated Point of View and Objectives are:

To stimulate the students' interest in research in the area of wood products, methods and techniques, and fabrication processes of the wood industries.
To provide an opportunity for students to work in the areas of their special interest.

WOODS AND WOOD TECHNOLOGY

Course Content, Activities, Techniques, Processes & Products

Level I - Exploring Woods & Wood Technology
Level II - Wood Technology
Level III - Advanced Wood Technology
Level IV - Specialized Wood Technology

Your attention is called to the following course content section. With the re-alignment of Industrial Arts curriculums into the various Levels, I-IV, it was felt that the scope of the process areas could be more effectively surveyed and utilized by the administrator, teacher, and student if listed consecutively by levels.

Suggested textbooks, page references and visual aids have been listed in the various levels to assist the teacher in covering the process areas. Other reference books or future editions of the suggested textbooks can be used successfully with the listed course content. This method of content organization should serve as an aid to the teacher.

The progressive arrangement of the areas and processes, by levels, will enable the teacher to select informational content according to the background, abilities, and objectives of the various classes or levels under consideration.

It was not the intentions of the woods curriculum committee that students in a given class or level, construct only the products in the guide but to use the information to design and produce similar products in the process areas. Administrators, teachers, and students should continue to update and expand the woods curriculum as new areas and processes are developed, using this guide as an example of the multi-process area approach to the teaching of woods in our industrial arts programs.

Suggested Textbooks, Levels I-IV

I Groneman, Chris H. and John Feirer. *General Shop*; Fourth Edition. McGraw-Hill Book Company, St. Louis, Missouri (533pp.), 1969.

II Feirer, John L. *Woodworking for Industry* and *Woodworking for Industry Workbook*. Charles A. Bennett Company, Incorporated, 908 West Detweiller Drive, Peoria, Illinois 61614 (672pp.), 1971.

III Zook, Wayne H. *Constructing and Manufacturing Wood Products*. McKnight Publishing Company, Bloomington, Illinois 61701 (475pp.), 1972.

IV Feirer, John L. *Cabinetmaking and Millwork* and *Cabinetmaking and Millwork Student Guide*. Charles A. Bennett Company, Incorporated, Peoria, Illinois 61614 (928pp), 1970.

SUGGESTED LEVELS I	II	III	IV	SUGGESTED STUDENT ACTIVITIES	SUGGESTED TEACHER TECHNIQUES
				AREAS & PROCESSES **A. Introduction**	
x				INTRODUCTION TO INDUSTRIAL ARTS AND WOODWORKING. Text I, pp. 1-2, 103-104.	Present an overview of the course, *General Shop*. Display and discuss products and processes representative of the area in which students will study, plan and/or construct products.
				INTRODUCTION TO WOOD TECHNOLOGY Text II, pp. 11-27.	Present an overview of the course. Display and discuss products representative of the process areas to be covered. Slides, S-2 and film, F-13.
		x		INTRODUCTION TO THE WOOD INDUSTRY Text III, pp. 1-24.	Discuss with each student his specialized interest(s) area of wood technology so that the course will fulfill his unique interest and needs. Determine objectives of the course. Slides, S-2.
			x	INTRODUCTION TO WOOD SPECIALIZATION Text IV, pp. 16-22. Additional designated references in the area of his specialty or research activity.	Each student must receive individual attention, outlining his or her chosen specialty. Students enrolled in Level IV will possibly have to do individual study on basic tool, machine wood processes before manipulative activities can be commenced. Slides, S-4.
				AREAS & PROCESSES **B. Product Design**	
	x			PRODUCT DESIGN Text I, pp. 2-12. Collect pictures, products and/or sketches that illustrate the creative, technical and the aesthetic parts of design.	Discuss formal and informal design approaches. Display and illustrate the various elements and basic principles of aesthetic design. Demonstrate sketching techniques used in pictorial drawings. Filmstrip, FS-1.

SUGGESTED LEVELS I	II	III	IV	SUGGESTED STUDENT ACTIVITIES	SUGGESTED TEACHER TECHNIQUES
	x			WOOD PRODUCT DESIGNS Text II, pp. 32-42. Collect pictures, products and/or sketches that illustrate good and bad design features. Design Problem: Design a book support on paper. Use clay, cardboard or balsa to show your design in 3-dimensional form.	Review Level I design presentation. Stress secondary principles of aesthetic design and applications of the design process. Illustrate how various elements and principles of design can be blended into a product. Discuss good and bad product designs. Review pictorial sketching techniques. Film, F-2.
		x		PRODUCT AND PACKAGE DESIGN STUDY Text III, pp. 97-101. Study assigned design reference topics and aid in presenting a group report. Design and construct a commerical-type package for the book support designed in Level II.	Assign topics in one of the design references for a group presentation to the class. Display and discuss various designs for the packaging industry. Speaker: Industrial designer from industry. Film, F-14.
			x	FURNITURE, JIG, & FIXTURE DESIGNS Text IV, pp. 29-57. Redesign a product. (Suggestion: the interior window shutter of the Production Product of Industry Process.) Design a jig and fixture to aid in assembly of the rails, stiles, and louvers of the interior window shutter.	Give individual assistance where necessary for the individually assigned design problems.
				AREAS & PROCESSES C. Develop Product Drawings, Planning, Plan or Order of Procedure and/or Methods Study	
x				PLANNING YOUR PRODUCT Text I, pp. 13-15, 53-102. Select one of your small products in the Product Design area; sketch a working drawing with details, dimensions, bill of materials, and plan the procedure for construction of the product.	Demonstrate free hand drawing of the alphabet of lines, lettering, dimensions, conventions and symbols as used in the working drawing. Demonstrate how mechanical drafting equipment is used in construction of orthographic projection and pictorial drawings. Show and discuss hard and softwood and plywood grades.
				PURCHASING LUMBER Text I, pp. 115-117. Apply to your bill of material section.	Demonstrate board foot measure. Discuss green and dry lumber conditions. Show wood samples and information cards. Selected visual aids.

	x			DESIGN AND PRODUCT METHODS STUDY Text II, pp. 43-77. Sketch or use mechanical drafting equipment in completing an orthographic projection drawing of the book support you designed in the Product Design area. The drawings should be complete with all specifications, bill of materials and a methods study.	Review demonstrations on free hand and the use of mechanical drafting equipment shown in Level I. Show samples of working drawings that have been used to construct products. Point out differences between working and industry's production drawings.
				SEASONING, GRADING & BUYING LUMBER FOR PRODUCT DEVELOPMENT. Text II, pp. 103-126.	Discuss and show samples of lumber seasoning, moisture content, grades and stock shapes and sizes. Figure board feet. Figure moisture content by oven dry method. Identify various wood samples and use information cards. Field trip: Lumber yard. Selected visual aids.
		x		PRODUCT ENGINEERING & PRODUCTION METHODS Text III, pp. 101-106, 355-362. Layout and assemble process route sheets with component drawings of the In-Out Tray found in the Lamination Process Area.	Show product route sheets used in a wood products industry. Speaker: Methods engineer or a motion and time study man. Visit: Wood products industry. Film, F-3.
			x	PRODUCT MANUFACTURING Text IV, pp. 174-226, 875-894. Layout an operation process chart for the In-Out tray found in the Lamination Process Area. Collect improved and/or reconstituted samples of woods. Complete an information card for each sample.	Visit: Industrial engineer of a local wood products industry to discuss industrial production method of product planning. Discuss advantages and/or disadvantages of improved and/or reconstituted woods over natural, unprocessed woods.
				AREAS & PROCESSES D. Safety	
x				SAFETY Text I, p. 105, 165-197. Make a list of one line caution or safety rules. Read and note page number of lists of safety rules for machines.	Discuss general type physical, clothing, tool and materials safety; also shop or laboratory courtesy. Stress specific safety rules regarding tools, machines and equipment. Film, F-1.

SUGGESTED LEVELS I	II	III	IV	SUGGESTED STUDENT ACTIVITIES	SUGGESTED TEACHER TECHNIQUES
	x			SAFETY, STUDY AND APPLICATION Text II, pp. 28-31. Collect cartoon-type posters stressing safety, and give short presentation to class.	Review safety procedure of Level I. Demonstrate general type cuts on machines, stressing safety procedure. Discuss first aid facilities and placement of fire extinguishers. Film, F-12 and filmstrip, FS-5.
		x		SAFETY IN THE WOODS LABORATORY Text III, pp. 119-127. Survey woods laboratory and make a list of unsafe or unguarded tools, machines, equipment and/or facilities.	Review Level II safety procedure. Work with students to eliminate all unsafe conditions found in their survey. Selected visual aids.
			x	SAFETY AND ITS IMPLICATIONS FOR INDUSTRY Text III, pp. 57-64. Report on state and federal safety organizations.	Review safety procedure of Level III. Speaker: School or local safety personnel.
				AREAS & PROCESSES E. Career Opportunities	
x				DEVELOPMENT AND ORGANIZATION OF AMERICAN INDUSTRY. Text I, pp. 16-43. Write a short report on some phase of a wood products industrial job that interests you.	Discuss development and organization of industry. Discuss areas of employment opportunity. Film, F-10 or Film, F-13.
	x			CAREER OPPORTUNITIES IN WOOD PRODUCT INDUSTRIES Text II, Review pp. 13-27. Become acquainted with industrial job opportunities and leisure time activities in the wood products industries.	Discuss areas of occupational employment; skilled, semiprofessional and professional. Speakers: Seminar type presentation in the three areas above. Film, F-8.
		x		CAREERS IN THE WOOD INDUSTRIES Text III, Review pp. 7-24. Read the Library Study of Salaries and Job Opportunities in wood products industries and survey the Missouri and U. S. Employment Service Publications.	Discuss enlarged earning power in wood product industries with advanced education. Present and discuss Occupational Outlook Handbook. Film, F-18.

				x	CAREERS--PROFESSIONAL OR TECHNICAL Survey Missouri and U.S. Employment Service Publications for job opportunities. Do a self-evaluation profile for an individual study. Make a study of and compare different schools of advanced education.	Give students a breakdown of the advantages for a non-high school, high school, trade school and college or university graduate. Speaker: Counselor on trade school, college and/or university opportunities. Filmstrip, FS-7.
					AREAS & PROCESSES **F. Forest Products**	
	x				FOREST PRODUCTS Text I, pp. 111-115. Collect picture samples or sketches of materials or products produced from plywood, laminated materials paper, rayon, wood chips or by-products of the wood products industries.	Discuss manufacturing of lumber from the forest through the mill to the drying yards Show manufacturing methods used to produce veneer, plywood, hardboard and particle boards. Filmstrip, FS-2 and filmstrip, FS-3.
		x			MANUFACTURED WOOD PRODUCT MATERIALS Text II, pp. 127-170. Prepare a paper on a selected forest product covered in this unit or one that has replaced one of these products.	Discuss forest logging practices, manufacturing of lumber, reconstituted wood products, processed wood and plastic products. Field trip: To a saw mill or other appropriate industry. Film, F-6.
			x		STANDARD MATERIALS FOR WOOD PRODUCTS Text III, pp. 59-81. Make a list of all standard materials found in your home: place emphasis on wood products and accessories that facilitate fabrication and beautifies the product.	Discuss the influence of standardization on manufacturing and product availability. Film, F-11.
				x	IMPROVED AND RECONSTITUTED WOODS Text IV, pp. 116-147, 575-592D, & 761-769. Prepare a research paper and collect samples of plastic laminates used in our homes and travel vehicles.	Discuss characteristics of improved and reconstituted wood products as they apply to wood products. Make available to the students the addresses and publications of organizations such as Forest Products Laboratory to aid them in their research papers. Film, F-15

SUGGESTED LEVELS I	II	III	IV	SUGGESTED STUDENT ACTIVITIES	SUGGESTED TEACHER TECHNIQUES
				AREAS & PROCESSES G. Wood Structure, Properties, and Identification	
x				COMMON WOODS See Process VII Text I, pp. 106-110 Indentify 10 species of wood (5 hard and 5 soft). Sketch or collect leaves or fruit from each (10) tree species. Collect pictures or sketch overall shape of each tree species selected.	Discuss various forest areas in the United States and their necessity to our modern society. Speaker: Local nursery operator or authority. Transparencies, T-5.
	x			WOOD MATERIAL TECHNOLOGY See Process VII Text II, pp. 78-102, 171-184, & 626-645. Obtain a cross-section of a tree trunk and label the parts. Combine this with PEG Process and show results of modern technology. Identity an additional 10 species of wood with added paper and/or collection as in Level 1.	Demonstrate wood structure study equipment from Process VII. Demonstrate specific gravity of wood by flotation method. Demonstrate Universal Test ng Equipment or laboratory type constructed testing unit. Transparencies, T-6.
		x		WOOD TECHNOLOGY See Process VII Text III, pp. 82-96. Label the 20 species of wood you learned to indentify in Levels I and II as to type of cell structure and specific gravity. Test as many of the wood species as feasible as to comparative strengths.	Demonstrate the use of moisture meters and/or oven dry method to determine moisture content. Review the Universal Testing Equipment and complete all the tests that you have accessories for. Demonstrate the expansion and contraction of various woods. Film, F-24 and Slides S-1.
			x	WOOD--ITS NATURE,PROPERTIES, AND SELECTIONS See Process VII Text IV, pp. 66-116. Select 10 wood species not in the department's wood study structure unit; complete cards and prepare samples for use by students in Levels I-IV. Design and/or construct a device to do material or structural testing.	Discuss characteristics of expensive woods commonly used in producing wood products versus the inexpensive substitue woods available. Discuss the characteristics of substitute materials commonly used for wood in the manufacturing processes such as plastic and metals. Speaker: Furniture store manager and or sales person. Film. F-9 and Slides S-5.

	x				LAMINATION, GLUING AND CLAMPING See Process I Construct suggested product, *Napkin Holder*, or use as guide for product development. Text I, pp. 160-162.	Demonstrate the process by applying glue to veneers of the napkin holder body and base and clamp on prepared forms. Discuss and demonstrate hand tools in the areas of measurement, layout, sawing, shearing, scraping, drilling, boring and forming wood.
					WORKING WITH HAND TOOLS Text I, pp. 118-148 Layout and form irregular pieces.	Discuss and demonstrate the following listed machine tools and portable power pieces of equipment, specifically pointing out safety guards, correct procedures and basic cuts or operations to be performed. *Students at this level should use machine tools only after proving themselves capable to do so;* using the table and jig saw and the applicable portable power pieces of equipment.
11					SURFACE PREPARATION & ASSEMBLY METHODS Text I, pp. 175-176, 148-162, 184-185 Rough sand components, fabricate and finish sand for application of decorative and/or protective finish.	Discuss and demonstrate abrasive hand and power sanding; fabricating with screws, nails, dowels, joints and adhesives; and final sanding methods prior to finish application.
					FINISHING OF WOOD SURFACES Text I, pp. 185-192 Apply finish to fabricated product.	Discuss and demonstrate use of surface and/or penetrating type finishes. Stress methods of rubbing out the finish to the desired luster. Speaker: Church architect. Filmstrip, FS-8.
		x			LAMINATING AND BENDING See Process I Construct suggested product, *In-Out Tray*, or use as a guide for product development. Text II, pp. 372-382, 337-351. Prepare veneers for adhesives, apply, clamp, dry, and remove excess glue from edges with band saw or rasp.	Demonstrate the process of laminating by using the tension strap and mechanical clamp method on prepared form or caul. Discuss characteristics of adhesives, problems in gluing, methods of applications, clamping devices and drying schedules. Film, F-7.

SUGGESTED LEVELS I	II	III	IV	SUGGESTED STUDENT ACTIVITIES	SUGGESTED TEACHER TECHNIQUES
				ROUGH AND FINISH MILL PROCESSES Text II, pp. 219-274. Machine laminate legs to size using band saw and jointer. Machine tray components to rough dimensions.	Demonstrate the proper use and maintenance of power pieces of equipment in the woods laboratory. Stress safety procedures to be observed at all times; special set-ups on all pieces of equipment must be approved by the teacher before using.
				Text II, pp. 313-336, 275-301. Set up radial arm or table saw and cut finger joints. Have teacher inspect special set-up before cutting joints. Complete all tray joint cuts.	Demonstrate special set-up on jointer, band, table and/or radial arm saw to process laminated and/or special cuts.
				FABRICATION AND FINISHING PROCESSES Text II, pp. 383-393, 352-371. Rough sand, fit and finish sand all components to be secured by adhesives and/or mechanical fasteners. Assemble all components.	Discuss abrasives, minerals, backing and bonds. Cover grit and/or numbering systems, forms and selections of abrasive materials. Filmstrip, FS-6. Demonstrate proper and safe use of portable power and stationary power pieces of abrasive machines. Discuss and illustrate various mechanical fastening devices and demonstrate methods of fastening.
				Text II, pp. 592-625. Touch-up, finish sand and prepare product for desired finish. Apply finish with materials and procedure most appropriate for products use.	Discuss finishing tools, methods and procedures to be followed. Demonstrate hand and spray type methods of finishing. Discuss opague, translucent, transparent, penetrating oils and waxes used in the finishing process. Stress methods of rubbing out a finish with various abrasives and lubricants to the desired luster. Film, F-17.
			x	PRODUCTION OPERATION THEORIES Review Process I Text III, pp. 25-58, 251-257 & 108-118. Design a product using the principles of lamination as a component or as a total product.	Review or repeat demonstrations given in Level II, Area H, Process I above. Stress should be placed on using machines in special production set-ups.
				Select a method of jigs and fixtures, cauls, forms, or clamping devices to produce blanks for the products designed.	Demonstrate the use of the band saw in producing veneers in thicknesses of one-sixteenth inch and over for larger laminates.
				Read reference articles at the end of Process I to help in your design or redesign. Complete drawings and methods study for product and forms to be constructed.	Discuss and demonstrate principles and the techniques of bending solid wood by the steaming or soaking methods. Film, F-23.

					PRODUCT PRODUCTION OPERATIONS & FINISHING TEHCHNIQUES Text III, pp. 128-251, 276-354. Order materials, fabricate forms or cauls for product components, laminate blank, finish components, assemble and apply finish to product designed.	Discuss the machine production processes of separating or rough mill type activities as supplementary to the principles of finish mill activities such as planing, shaping, forming, boring and drilling. Visit: A successful wood products industry that specializes in automatic equipment, use of improved woods and electrostatic or other current finishing equipment. Transparencies, T-1.
				x	SELECTED PRODUCT CONSTRUCTION STUDY Review Process I Text IV, pp. 488-506, 533-575. Choose or design a product that reflects your interest in this process area and continue to build on skills and knowledge developed in Levels II and III. or Text IV, pp. -836-913. Construct a prototype of a product to be constructed by students in Levels I and II. Design the product, layout methods study, jig and fixtures, components and a variety of product styles to be constructed by students in Levels I and II. or Select a laminated product or component and conduct experiments as to the adhesives, woods, jointery and/or finishes used in its assembly or construction. Mechanical as well as chemical testing equipment should be utilized in your experimentation and/or research.	The student(s) choosing a Level IV course has a specialized need and should be allowed to develop his interest and abilities as far as possible in satisfying his general education electives and/or as a preparation for a specific vocation. The text assignments are selected to guide the student readings in the interest areas of his or her choosing. It is suggested that this course be conducted in a manner similar to a special problems or investigations course that you (the teacher) would like to enroll in or have credit for in your undergraduate or graduate work in a college or university. Visit: A wood products research or testing center. Film, F-26.
					AREAS & PROCESSES I. PEG Diffusion Process	
	x				SELECTED POWER MACHINES & PORTABLE POWER TOOLS See Process II Construct the suggested product, *Log disc*, to be used as a base for planters, decoupage or interest center. A shallow bowl could also be selected as the first product in PEG.	Discuss the theory and cover the basic steps used in stabilizing green wood with polyethylene glycol, PEG.

SUGGESTED LEVELS I	II	III	IV	SUGGESTED STUDENT ACTIVITIES	SUGGESTED TEACHER TECHNIQUES
				Text I, pp. 165-175, 177-183. Saw green log disc or blank into rough form. If the product is a bowl, rough turn on lathe.	Discuss and demonstrate the following listed machine tools and portable power pieces of equipment, specifically pointing out safety guards, correct procedures and basic cuts or operations to be performed. *Students at this level should use machine tools only after proving themselves capable to do so.* Drill press, lathe, band saw and the portable power pieces of applicable equipment should be demonstrated.
				CHEMICAL TREATMENT & PROCESSING OF WOOD Treat or soak green wood in either a PEG cold or elevated temperature container.	Demonstrate how to use a hydrometer and discuss specific gravity of liquids. Discuss methods used to preserve wood by the soaking method.
				Dry to equilibrium moisture content by room temperature or elevated heat.	Review methods used to dry wood materials or products to correct moisture content. Transparencies, T-7.
				Finish machining or use hand tools to size, sand and prepare product for a finish.	Discuss abrasives, forms, grits and correct methods of use.
				Apply surface or penetrating finish to all surfaces, rub out finish with abrasives and apply a protective coating of wax.	Contrast surface and penetrating types of finishes as applicable to design form and/or use.
	x			WOOD SCIENCE APPLICATION See Process II Design a *Bowl* or *Tray* to be turned on the lathe. The product should be rough turned from green or wet wood taken from a tree trunk or limb. Text II, Review pp. 171-188.	Discuss the theory and review the basic steps used in stabilizing green wood with polyethylene glycol, PEG.
				LATHE USE & TOOL SHARPENING TECHNIQUES Text II, pp. 302-311. Rough turn, soak, dry, finish turn, sand and apply finish desired.	Demonstrate faceplate type turning using scraping tools on concave and convex surfaces.
				See Level I for basic operations on PEG process.	Review general topics covered in Level I regarding these allied areas; however, more details and discussions should be allowed or encouraged by students. Transparencies, T-8.

					Text II, pp. 201-218. Sharpen hand tools used on the wood lathe.	Demonstrate methods used to sharpen hand tools, adjust and change cutting tools used on power machinery.
			x		FORMING CYLINDRICAL OR IRREGULAR SHAPES Review Process II If this process area is chosen as a special interest area, study the references listed at the end of the process area. Text III, pp. 258-275.	Suggest in-depth study of the process area and suggest a variety of objects that could be carved as a product.
					A suggested area of manipulative expression could be in the hand tool carving of a variety of objects approved by your teacher. Submit sketches shown in four or more profiles to aid in your carving.	Present a variety of articles that will stimulate your students into product development in this important area of waste tree parts. Film, F-22.
				x	EXPERIMENTAL & APPLICATION OF THE PEG PROCESS Review Process II Experiment with polyethylene glycol having different specific gravities than that used in Levels I-III.	See Teacher Techniques in Level IV in Process Area H above.
					Experiment with mixtures, soaking schedules, drying schedules, and finishes to be used on PEG treated woods.	
					Construct PEG Thermo Tank if your woods laboratory department has been using the cold treatment process.	Furnish materials and assistance to the student(s) constructing the PEG Tank. Film, F-19.

AREAS & PROCESSES J. Wood Flour and/or Particle Molding	
IMPROVED, RECONSTITUTED AND MOLDED WOOD PRODUCTS See Process III Construct the suggested product, *Coasters*, or test disc to be blended into a product of your own design. Plywood could be set up and formed into switch or recepticle plates.	Demonstrate the process using the Trio Press. A commercial type Dake, Carver or Iasco's press could be used with adaptations.

SUGGESTED LEVELS I	II	III	IV	SUGGESTED STUDENT ACTIVITIES	SUGGESTED TEACHER TECHNIQUES
				Design a plate or decal for use in personalizing your coaster bases. Prepare particles by screening, proper blending with dry adhesives and/or dyes, weighing into correct amounts, molding, filing and buffing.	Discuss trade marks and/or surface type decorations as a design feature on molded products. Discuss manufacturing methods used in producing flakeboard, particleboard, hardboard and plywood. Discuss adhesive forms, characteristics, time cycles and the advantages of heat during the curing process. Discuss recycling of waste materials from a wood products plant into useful manufacturing materials as a means of conservation and air pollution control. Speaker: Lumber yard manager or building materials sales person.
	x			PATTERNMAKING See Process III Design a mold or test disc die and plunger for the Trio Press. Text II, pp. 460-474.	Display products that can be produced by molded wood particles. Suggest product redesigns where applicable.
				Select patternmaking wood, glue, turn on lathe, sand and apply finish. Patterns can also be designed to be finished on machines other than the lathe.	Discuss and review properties of wood that lend themselves to patternmaking materials.
				Test finished pattern by ramming up the mold, pulling the pattern and pouring the casting.	Demonstrate methods used in the foundry area. Visit: Patternmaking shop and the foundry connected with it. Selected visual aids.
				Finish turning or finish casting to designed dimensions. Secure in press and run test blanks. Make corrections if necessary. Use procedure and skills learned in Level I. If the designed mold produced a material that can be fabricated into a product--complete the product.	Demonstrate or allow a student in the metals area to machine the rough casting to finished dimensions.
			x	PATTERNMAKING FOR APPLICATION Review Process III If this process area has been chosen as a special interest area, study the references listed at the end of the process area.	Make available to student(s) articles and/or materials that would stimulate their research activities.

					Using the test disc mold, experiment with a variety of mixtures of wood and adhesives using various heats, pressures and time cycles to produce materials of desired densities and textures. Text III, pp. 382-387.	Show samples of reconstituted woods used as building materials. Stress recycling procedures as a means of producing usable materials from waste products. Film, F-20.
					Using the Universal Tester or appropriate laboratory constructed testing equipment, test the discs produced for composite strength values.	Show and aid students in designing and using test sheets that will reflect the results of their experiments. Evaluations, conclusions and recommendations should be written and retained for use in this process area.
				x	EXPERIMENTATION & APPLICATION OF RECONSTITUTED WOODS Review Process III Continue experimentation as in Level III.	See Teacher Techniques in Level III above.
					Aid in constructing Trio Press and/or accessories to complete the woods laboratory equipment in this vital area of reconstituted wood products.	Furnish materials and assistance to the student(s) constructing the Trio Press and/or accessories. Selected visual aids.
					AREAS & PROCESSES K Production Product of Industry	
	x				MASS PRODUCTION See Process IV Use this process area as a guide to supplement suggested textbook assignment. Text I, pp. 43-52.	*Note*: It is recommended that this process area be instituted near the end of the regular school year or it could just as easily be omitted for Level I students! Show interior window shutter product and briefly cover major processes and charts found in Process IV that are necessary to produce a successful product. Compare the individual handcraft method of producing a product to the massproduction method; see chart p. 44 in suggested textbook.
					Select a product produced in your General Shop class to mass produce; redesign if necessary as a pilot model.	Set up or divide the class into groups to work out details involving manufacturing the product chosen. These groups are: manufacturing engineering, material selecting, personnel (management and production), quality control, production control, manufacturing and business activities. The time required by each group to set up this area may take considerable time, patience and effort at this level.

SUGGESTED LEVELS I	II	III	IV	SUGGESTED STUDENT ACTIVITIES	SUGGESTED TEACHER TECHNIQUES
				Produce product or components as time permits.	Evaluate the process area to note educational benefits at this particular level.
				Collect and bring to class examples of various manufactured products which show interchangeability and that could be used for making a display.	Discuss the importance of inspection and quality control in manufacturing industries to insure interchangeability of manufactured components.
	x			MANUFACTURE OF WOOD PRODUCTS See Process IV Use this process area as a guide to supplement suggested textbook assignment. Study references at end of Process IV. Text II, pp. 441-459. After selecting the interior window shutter as the product to be produced, organize production groups and use the charts and diagrams that have been developed.	*Note*: It is recommended that this process area be instituted near the end of the regular school year. The entire product does not have to be produced during a straight production sequence. The interior window shutter is designed so that various components can be produced, stored, and assembled in staggered scheduled runs.
				The production plannng team should carefully study the operation process chart, flow process chart, flow diagrams and component process route sheets.	Organize and/or aid students in setting up various production teams. It is suggested that the interior window shutter be used as the product to be produced as your first production product.
				Organize a crew to design and construct jigs and fixtures for component production and assembly of products. Organize a crew to design and construct gauges to test standardized parts. Organize a crew to order and make available raw materials for production. Assign class members to serve as production workers, material handlers, inspectors, motion and time study and assembly personnel.	After experience is gained in the area of mass production, considerable time can be spent in setting up student groups to organize companies, take or make product survey, develop various prototypes to be produced in the future, analyze the products as to charts and diagrams, set up production and packaging teams and sales and business personnel.
				Re-design interior window shutter for more efficient production in your woods laboratory.	Discuss mass production methods used in the school shop to those used in a wood products industry. Speaker: Methods engineer from industry. Filmstrip, FS-4.

			x		ELEMENTS OF MASS PRODUCTION Review Process IV Review Text III, pp. 355-362. The following steps must be employed to run a successful company: 1. Organize a company to produce wood products 2. Make a market study 3. Design the product 4. Construct a prototype 5. Study sequence of machines to produce product components 6. Prepare cost estimates 7. Develop operation process chart 8. Develop flow process chart 9. Develop flow diagrams 10. Design, construct and install production jigs and fixtures 11. Design special machine cutters 12. Design, construct and sample test control gages 13. Develop component process route sheets 14. Train production workers, using motion and time study techniques to improve production 15. Assign workers to production stations 16. Manufacture products 17. Inspect products 18. Package products 19. Distribute products 20. Distribute profits to stockholders 21. Dissolve company
				x	PRODUCTION EQUIPMENT STUDIES Review Process IV Text IV, pp. 836-874 and review pp. 875-894. Select text pages that apply to the product selected. If a product in one of the process areas is not selected, work with the teacher to improve mass production manufacturing techniques in the planning, executing and distributing of manufactured products in Levels I-III.

If the students have gone through the Production Product Process in Level II and produced the window shutters, it would be desirable not to play the "production role" ranging from the product market study to the dissolving of the company.

Discuss:
1. Methods of organizing a student products company
2. Importance of management
3. The role of research and development
4. Product design teams
5. Production planning departments
6. Trade unions
7. American Society of Mechanical Engineers
8. Importance of quality control
9. Variety of personnel management
10. Methods of manufacturing
11. Scope of marketing
12. Stocks and investments

Speaker: Manager from successful wood products industry.
Slides, S-3.

It is not recommended that this process area be used in Level IV.

If a student(s) elects to study the manufacturing process, lend assistance in every possible area of his selection. The student could serve as a research engineer or specialist in Levels I-III production product areas.

SUGGESTED LEVELS I	II	III	IV	SUGGESTED STUDENT ACTIVITIES	SUGGESTED TEACHER TECHNIQUES
				AREAS AND PROCESSES L. Wood Plastic Composition (WPC) Process	
x				This process area is not recommended for this level except to use the WPC processed wood in product development.	Discuss and demonstrate the WPC process by using water instead of the chemical, methyl methacrylate. Demonstrate the Universal Testing Machine by using WPC processed woods in hardness, compression, bending and shock resistance tests.
	x			CHEMICALLY PROCESSED WOODS See Process V Study the references listed at the end of the process area. This process area is not recommended for this level except to use the WPC processed wood in product development.	Discuss and demonstrate the WPC process by using water instead of the chemical, methyl methacrylate. Film, F-25.
				Run tests on WPC woods with Universal Testing Machine or a laboratory constructed testing center.	Discuss characteristics of WPC processed woods as to structure, finish and adaptability to wood products. Show methods used to record experiments and results of WPC woods produced by students in Levels III and IV.
		x	x	PRODUCTION AND APPLICATION OF WPC PROCESSED WOODS See Process V Study the references listed at the end of the process area. Conduct a "dry-run" (or with water) on the WPC equipment to insure that all equipment is functioning properly, materials available, and safety procedures understood.	Supervise the "dry-run" (or with water) on the WPC equipment.
				Produce Methacrylated Wood for experimentation, research purposes or for product development in Levels I-IV. Follow procedures carefully as set up in Process V. This procedure has been carefully and successfully tested by the woods curriculum committee and students in a woods laboratory situation with satisfactory and fascinating results.	Discuss the future of WPC woods produced by nuclear radiation or by the chemical initiator process. Film, F-4.
				If your woods laboratory does not have WPC equipment, aid in the assembly of the units as described in the process area.	Work with selected students in woods or metal classes to machine, fabricate and assemble the WPC unit for the woods laboratory.
				Design and construct products using WPC processed woods as part of or for the entire product.	*Note*: It is not intended that the woods laboratory be used only as a science material approach to industrial arts, but rather as a science material product approach.

x					RESIDENTIAL CONSTRUCTION This process area is not recommended for this level except to indicate the scope of the woods product industries.	Show and discuss models of house construction assembled in Levels II and III to stimulate interest in this area.
	x				BUILDING CONSTRUCTION See Process VI Text II, pp. 486-591	It is suggested that this process area material be carefully followed the first time it is taught. The procedure and materia's have been carefully tested by the Woods Curriculum Committee and students in a woods laboratory and has worked out satisfactorily. Alterations in house design is suggested for the second year of residential construction. Film, F-5 and Transparencies T-2.
					Produce scaled residential dimensional lumber. Elect or assign one-fourth of the class to specific duties in completing the various sections of the house under construction. Foreman, material handlers and crew members should understand their new assignments each week of the semester.	Discuss reasons for, and production of all residential construction scaled lumber by total class participation during the first part of the school year. Discuss modern methods to "stick type" residential construction by teams rather than by individuals.
					Finish out the various sections of the house as time permits during each semester of the school year. Sketch or layout on paper the position for utility installations in the section of house under construction. Sketch on paper positions of furniture in the section of house under construction.	Discuss the various "systems" approaches to residential construction such as factory produced houses ready to be placed on the finished floor assembly, and manufactured trusses as contrasted to conventional "stick type" rafters. Speakers: City housing inspector and a custom house contractor.
		x	x		BUILDING CONSTRUCTION PRACTICES See Process VI Text III, pp. 388-425. Text IV, pp. 139-147, 728-784D.	*Note*: If this process area was not covered in Level II, follow activities and techniques columns in Level II above, if the area was covered, use the suggestions that follow. Transparencies, T-3.
					Design and construct jigs and fixtures for producing the residential construction house by the "systems" approach.	Discuss the theories and applications of "manufactured" homes: and modular constructed homes. Film, F-21.

SUGGESTED LEVELS I	II	III	IV	SUGGESTED STUDENT ACTIVITIES	SUGGESTED TEACHER TECHNIQUES
				Redesign the residential construction house with a different floor plan and a hip type roof.	Display house designs of a variety of styles that should be constructed on a specific plot. Film, F-16.
				Figure the current construction cost of the residential construction house under construction in Level II. Figure the total cost of the house in terms of: rough and finish construction, installation of utilities, and permanent pieces of furniture, plot and the selling price.	Discuss the influence of adhesives, automatic nailing machines, custom erecting hoists, transportation problems and people prejudices regarding current modern construction techniques. Speakers: Modular construction contractor and manager of a manufactured home industry. Slides, S-6.

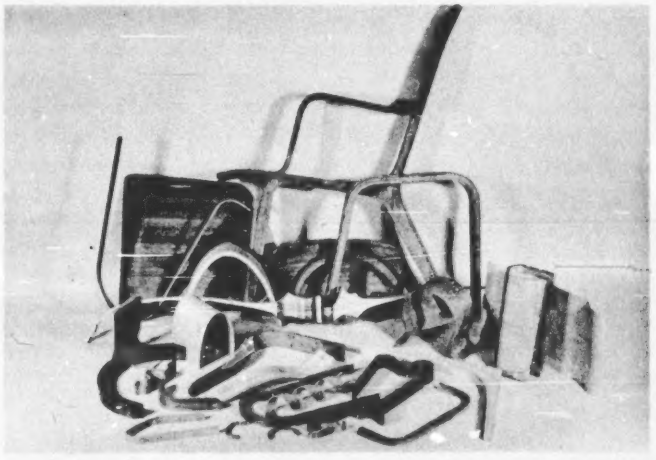
I. WOOD LAMINATING

The art and practice of laminating wood has been known since the 15th Century, B. C. The process is currently an important procedure in modern wood products industries. The range of articles produced by this process varies from a single component item such as a candle holder, to large multiple complex components to be assembled as laminated roof arches or naval vessels.

Lamination is accomplished by gluing two or more layers of solid woods with the grain approximately parallel. The design of some laminated components however, make it necessary to assemble the veneers with the grain of adjacent layers at right angles as used in conventional plywood construction. This method of fabricating tends to more or less stabilize the final glued form.

The two products selected in this area of woodworking, napkin holder for Level I and in-out tray for Level II, should prove challenging and yet allow a sufficient amount of individual design and expression. The 1/28 inch standard thickness veneers used in the two product's laminated components can be purchased from any company dealing in industrial arts woodworking supplies and equipment.

For larger designed products, (Fig. 1-1) veneers of a variety of thicknesses can be produced in the laboratory area using a ½ inch blade on the bandsaw. This method of veneer production however, produces a high degree of waste materials and student time consumed. It is desirable, but not necessary, that the resawed surface be planed in the surfacer for a smoother glue joint. The following procedure has been successfully used to produce veneers of selected thicknesses and width.



Wood Laminated Components [Fig. I-I]

Select stock for straight grain, free of knots, defects or highly figured grain. Rip stock to desired width. For ease in resawing the material should not exceed 2½ inches. Surface or face plane 2 sides or select S2S stock. Joint the edges to aid in gluing veneers if a wider laminate is required. Set up a temporary guide or rip fence on the band saw for thickness of veneer strip desired; allow for additional material to be removed in the surfacer if S2S veneers are to be used. Place the surfaced face of stock against rip fence and resaw veneers. Repeat for second surfaced side; a feather board secured to the table aids in holding stock against the fence while cutting. If a surfaced side is desired for the next resawing operation, plane the stock left after the initial resawing. Continue resawing and surfacing as long as stock remains. Place resawed veneers on supporting board, sawed surface up, and plane all veneers to equal thickness.

The adhesive selected to permanently bond the veneers will depend on the laminated products final use. The best adhesive is one of the synthetic-resin glues such as urea-resin (plastic resin) as they are water-resistant and remain fluid sufficiently long enough to allow final clamping time.

Clamping devices used in the two products selected are inexpensive to fabricate and can be used on a variety of designed product forms. Other methods successfully used to apply pressure to the veneers are: firehose, rubber strips from inner tubes and a variety of standard woodworking clamps. Forms, cauls, molds, and/or jigs can be fabricated from a variety of materials and faced with rubber, metal or cork to give the surface desired.

LAMINATED NAPKIN HOLDERS WITH JIG AND FIXTURES

I. *Bending Form*

1. Order and receive required material.
2. Surface and square stock to ¾".
3. Apply adhesive to inside surfaces and clamp securely; allow correct drying time.
4. Remove excess dried adhesive, surface and square to finished dimensions.
5. Lay out radius on top and bottom corners of bending form as indicated on drawing.
6. Remove excess material from form, smooth to present smooth laminating surface.
7. Check final form with finished dimensions on drawing.

II. *Gluing Pads*

1. Order and receive required material.
2. Square to finish dimension.

III. *Clamping Fixture*

1. Order and receive material for webbing straps.
2. Surface and square to finish dimension.
3. Obtain upholster webbing, secure between 4 strips of hardwood according to drawing. Length is determined by thickness of finished laminated blank.
4. Webbing can be secured with machine bolts and or wood screws.

IV. *Continuous Form for Base or Footing*

1. Order and receive stock.
2. Surface and square to finish dimensions.
3. Lay out top outline of footing on form block. (To insure matching contour to base of laminated holder blank, use blank for top contour line.) Lay out on heavy paper and transfer contour to blank with awl by punching holes in block. Carefully lay out perpendicular lines to contoured line. Determine finish thickness of foot and lay out second or bottom contour line on form block. (Note: the forms will not function properly as cauls if only one contour line is sawed to separate form block.)
4. Carefully smooth matching contours of forms and square to surface of sides.
5. Cover matching contours with masking tape. Wax taped surfaces for easy removal of laminated form after adhesive has dried.

V. *Assembly of Base or Footing*

1. Mix and apply plastic resin adhesive on inside surfaces of assembled veneers.
2. Position assembled veneers between forms.
3. Place bar clamp in the middle of block form and apply pressure until the strips contour to the form.
4. Place hand screw clamps on each end of the block forms and remove bar clamps. Allow correct drying time. (If a high frequency wood welder is used this entire base or footing can be completed in 5 minutes time!)

VI. *Assembly of Napkin Holder Blank*

1. Mix and apply plastic resin adhesive on inside of assembled veneers. (Suggested method of assembly, use 5 plies--3 vertical and 2 horizontal for retaining shape of blank).
2. Position assembled veneers between protective plastic sheet or saran wrap to protect form fixtures from excessive adhesive being squeezed out.

3. Place laminates over bending form with webb clamping fixture over laminates and protective wrap.
4. Open bench woodworking vise and press laminates and fixture down into opening. This will aid in pre-forming fixture and laminates around form.
5. Secure hand screw clamps to webb wood strips pulling clamping fixtures tight around bending form.
6. Place plywood pads on the sides of the bending form and clamp with C clamps.
7. Adjust all clamps until they are secure and forming laminates to bending form.
8. Allow correct drying time. (It is suggested that blank be allowed to dry on form unclamped for 24 hrs. after correct adhesive drying time to aid in retaining shape. A laminated form such as this will draw together as it reaches equilibrium moisture content unless retained.)

VII. *Lay Out Napkin Holder (2) on Blank*

1. Develop pattern on stiff paper, cut out and secure to laminated blank.
2. Cut and insert temporary block inside blank to aid in supporting sides when sawed to final shape.
3. Sand and prepare edges for finishing.

VIII. *Prepare Base or Footing*

1. Saw one straight edge on laminated blank.
2. Rip 2 parallel pieces from each prepared blank to finish dimensions.
3. Cut to final length desired.
4. Sand and prepare edges for finishing.

IX. *Assembly of Napkin Holder*

1. Place feet under holder to fit contour and produce a pleasing effect as indicated on drawing. (Note and check holder for correct alignment in two dimensions. Suggested method would be to mark center line on bottom of holder, place on a level surface with feet under blank ½" from outside edge. Move blank to create desired effect and mark feet to match centerline of blank.)
2. Finish sanding all components before final assembly.
3. Secure 3 components with screws and/or adhesive.

X. *Finish*

1. Prepare assembled napkin holder for finish by touching up rough surfaces using abrasive and or steel wool.
2. Apply finish as desired. (Danish oil and wax is highly recommended).

IN-OUT TRAY WITH JIG AND FIXTURES

Leg Form Jig (Drawing No. 2 of 2)

1. Obtain 3 pieces of ¾ inch Douglas Fir interior plywood, 17" x 10".
2. Glue these pieces together (face to face).
3. Using drawing no. 2 of 2, lay out contour of jig on glued stock.
4. Cut on bandsaw, shape and sand edges.
5. Cut two pieces of 25 gage stainless steel straps 2 inches wide by 42 inches long.
6. Secure one strap around contour of jig edge with contact cement.
7. Shape the second strap around jig, allowing ½ inch for laminates, form a loop on the second end ½ inches in diameter to hold clamp pin.
8. Fasten this strap with wood screws as indicated on print; this strip will serve as a tension band.
9. Fabricate 2 pieces of angle iron forming a support for tension clamp plate.
10. Lay out and drill holes in jig for clamp pins.
11. Insert 5/8 inch diameter gas pipe into holes for support.
12. Using hardwood or plywood cut the three clamp blocks to contoured or squared shape.

Laminating Clamp (Drawing No. 2 of 2)

1. Cut the two clamp arms to finish dimensions as noted on drawing. Note: For the longer clamps these arms will be 3/16 x 1 x 8, all other dimensions being the same.
2. Locate and drill the hole for clamp pin.
3. Cut clamp head (5/8 x 1 x 2½)
4. Locate and drill 27/64 inch hole, tap threads ½-13NC-2A. (Hole must be drilled and tapped perpendicular to the face.)
5. Weld the arms to the head in the manner shown and finish welds smooth.
6. Cut clamp pressure plate. (9/16 x 7/8 x 2-3/8)
7. Locate and drill 23/64 inch hole, ¼ inch deep. Finish through stock with 7/32 inch drill.
8. Machine end of continuous threaded bolt (½-13NC-2A x 4-1/16) to .213 for 9/16 inches.
9. Plug weld nut to continuous threaded bolt end, grind weld, and assemble prepared clamp screw through clamp head.
10. Place machined end of clamp screw into clamp pressure plate as shown and flare end securing the two pieces together.
11. Cut pin from ½" diameter rod and bend one end to allow easy removal.

In-Out Tray (Drawing No. 1 of 2)

A. Legs

1. Cut 14 strips of 1/28 inch thick veneer.
2. With jig and accessories prepared, mix adhesive.
3. Apply to inner surfaces of veneer strips.
4. Piace stacked veneer in jig. (Plastic sheet strips should be on each side of the prepared veneers to prevent glue markings on jig and accessories.)
5. Position prepared veneers between stainless steel strips. Tighten tension band to 100 inch pounds with torque wrench.
6. Attach pressure blocks to top and bottom with clamps and tighten to 150 inch pounds.
7. Check tension band for contouring and apply 200 inch pounds pressure with torque wrench.
8. Inspect all pressure blocks to insure that all are positioned correctly and that the laminate is being compressed evenly; apply 200 inch pounds to pressure block clamps.
9. Dry for 24 hours at room temperature. (Drying can be accelerated in the Automatic Drying Chamber at 140 degrees F. for 2 hours.)
10. Remove from jig and allow to cure for appropiate time. (During this time laminate will pull down to desired shape.)

11. Mark the leg width and cut on bandsaw using fine tooth blade. Support the open end of the blank with a scrap piece of wood during the sawing operation.
12. Smooth edges on jointer or with rasp and abrasive paper.
13. Drill holes for bolts and counter-bore for nuts.
14. Finish the edges in manner desired (file, router, etc.) and rough sand.

B. Trays

1. Material for backs, front, and sides can be resawn from ¾ x 10 x 24 inch stock.
2. Joint and plane pieces leaving 1/32 inch for finish sanding.
3. Lay out matching finger joints on the stock.
4. Set up the radial arm saw and cut the finger joint (table saw can also be used).
5. Lay out and cut grooves for bottom in back, sides and front, using 1/8 inch single dado saw blade.
6. Assemble components and cut bottom for finish size (some sanding may be required on bottom to allow fit).
7. Drill holes in bottom and countersink for F. H. machine bolts.
8. Assemble all components to check workmanship.
9. Disassemble and lay out contour on sides of trays.
10. Cut contours on bandsaw and sand.
11. Finish sanding components in preparation for gluing assembly.

C. Assembling and Finishing

1. Apply adhesive to joints and bottom grooves.
2. Assemble the back and sides.
3. Place hardboard bottom in position.
4. Position front.
5. Place assembly in clamps (remove excess adhesive which squeezes out.)
6. Allow proper drying time for type of adhesive used.
7. Finish sand boxes and legs.
8. Trial assemble to test workmanship.
9. Disassemble, fill and stain if desired.
10. Apply Danish oil, or other finish desired.
11. Wax finish.
12. Reassemble.

The following articles, bulletins and references have been selected to give you a variety of techniques, processes and information.

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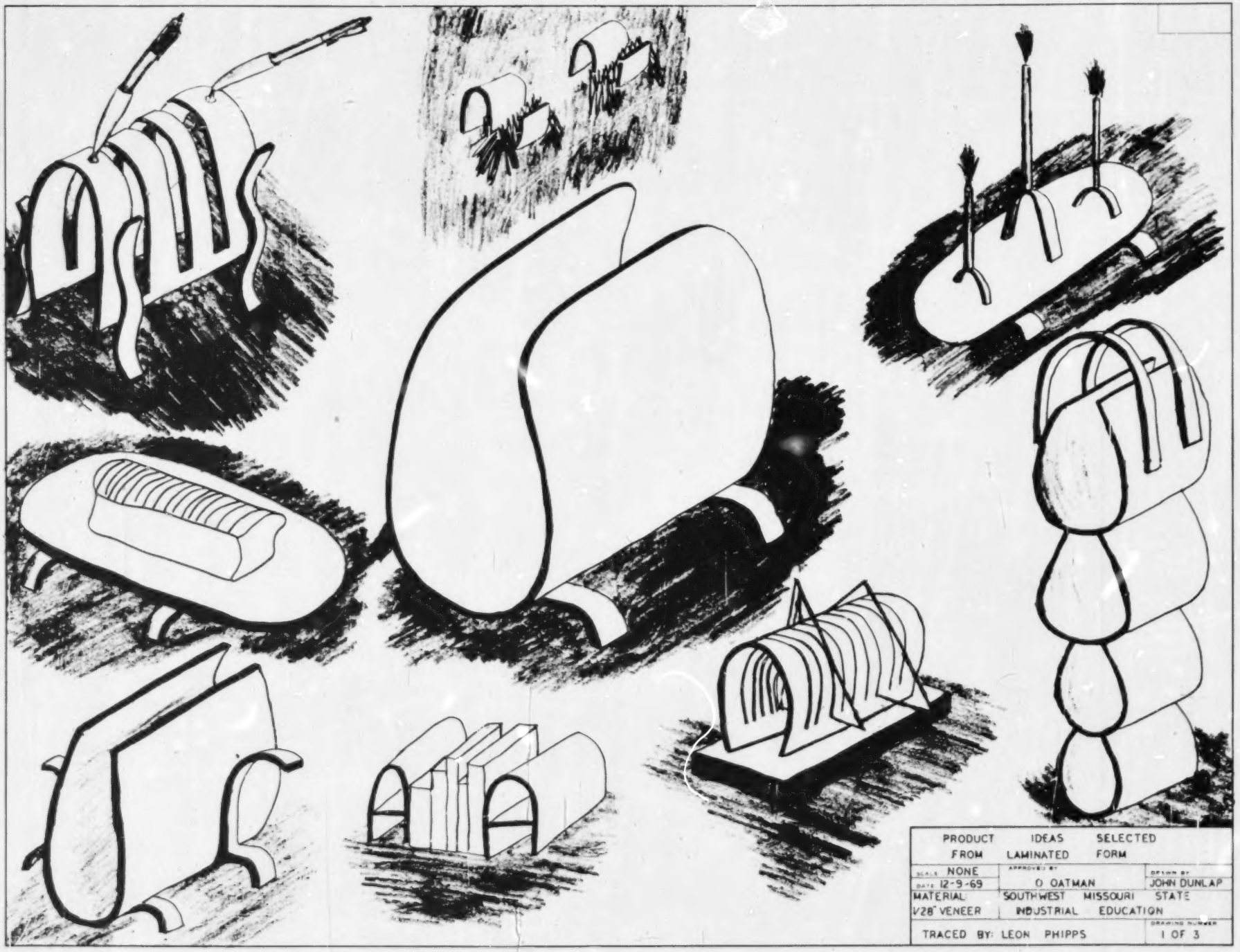
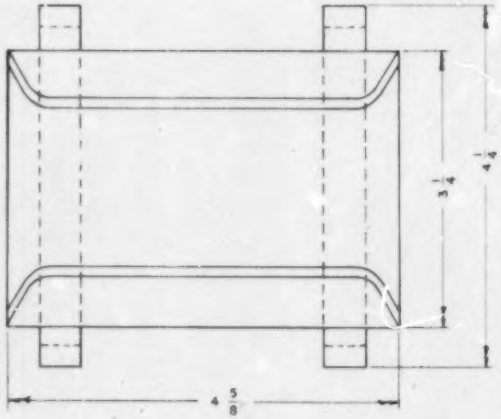


PRODUCT IDEAS SELECTED FROM LAMINATED FORM		
SCALE NONE	APPROVED BY O OATMAN	DRAWN BY JOHN DUNLAP
DATE 12-9-69		
MATERIAL V28" VENEER	SOUTHWEST MISSOURI INDUSTRIAL EDUCATION	STATE
TRACED BY: LEON PHIPPS		DRAWING NUMBER 1 OF 3



ASSEMBLY

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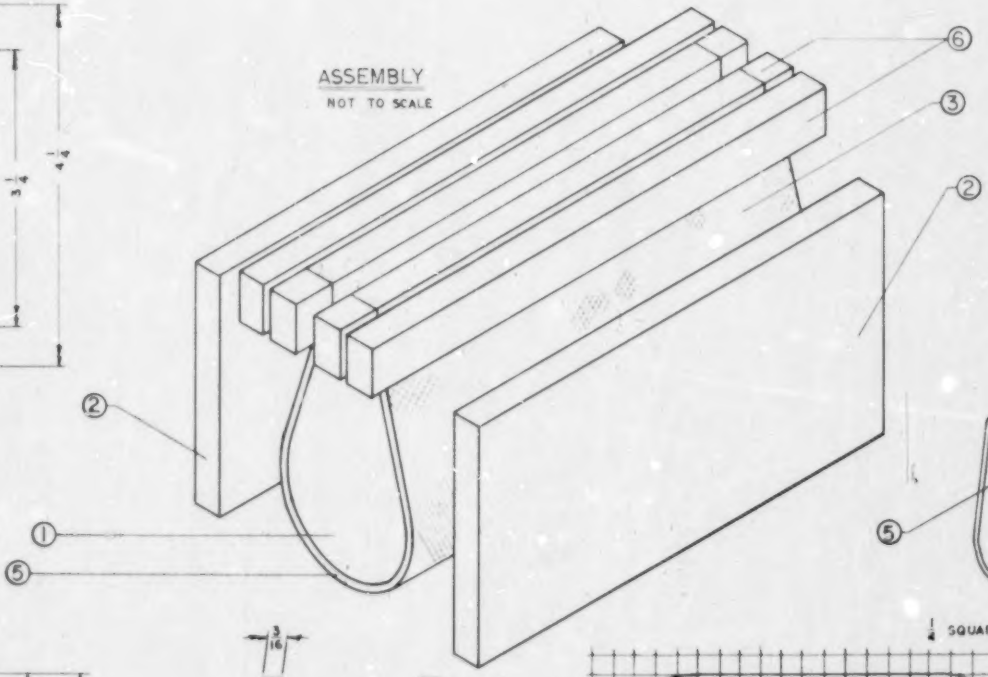

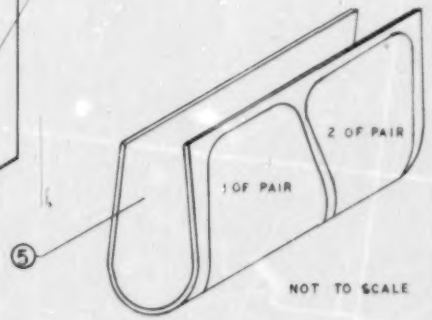

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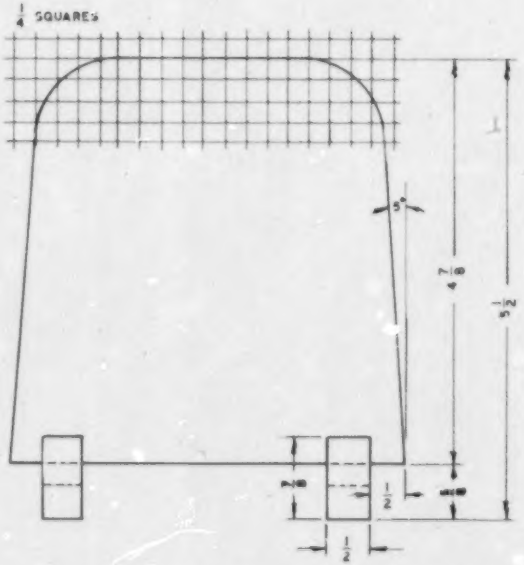
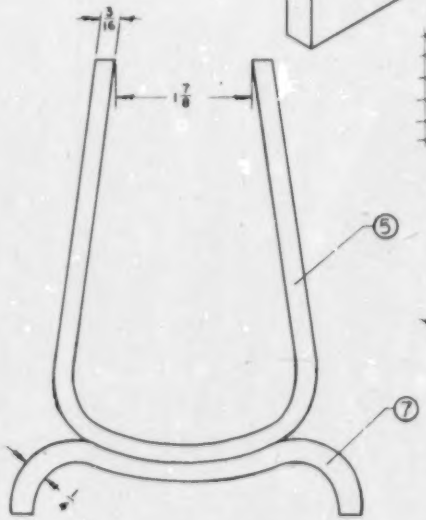
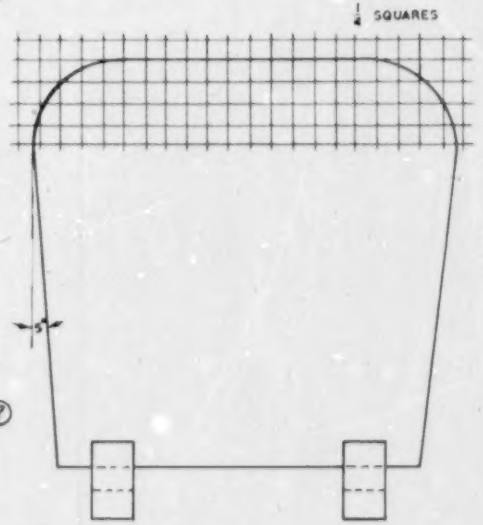
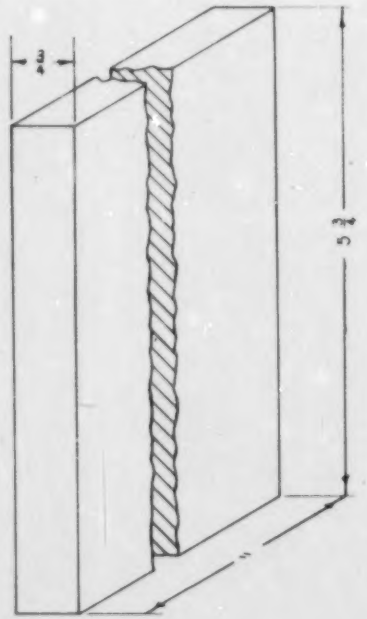


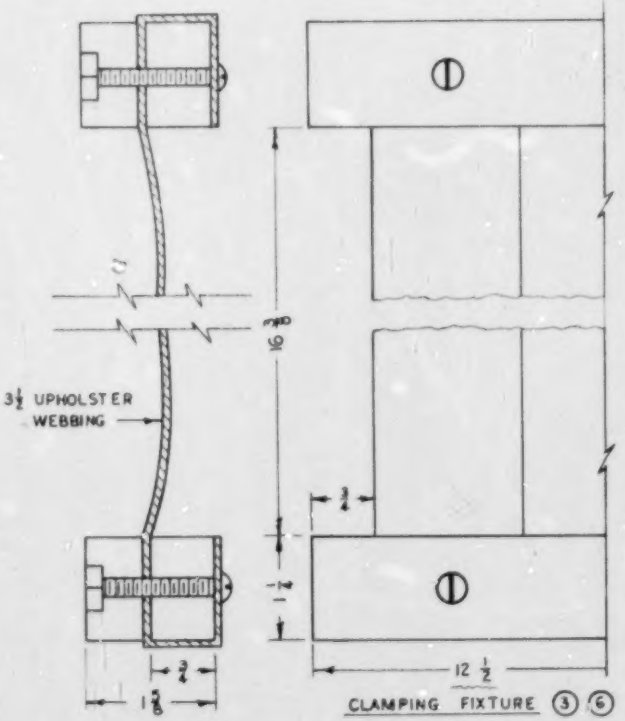




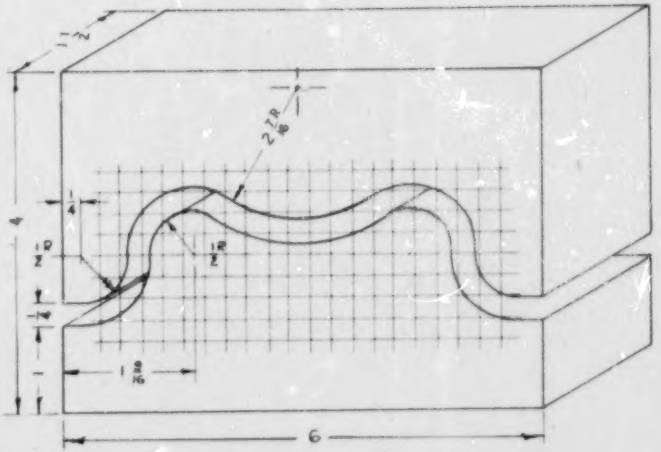
REVISIONS			NAPKIN HOLDER
NO	DATE	BY	JIG AND FIXTURE ASSEMBLY
			SOUTHWEST MISSOURI STATE INDUSTRIAL EDUCATION
			DRAWN BY: JOHN DUNLAP; SCALE: 10" = 10"; MATERIAL: 1/28 VENEER
			CHK'D: O C D; DATE: 12-9-69; DRAWING NO: 2 OF 3
			TRACED: LEON PHIPPS; APP'D: O OATMAN



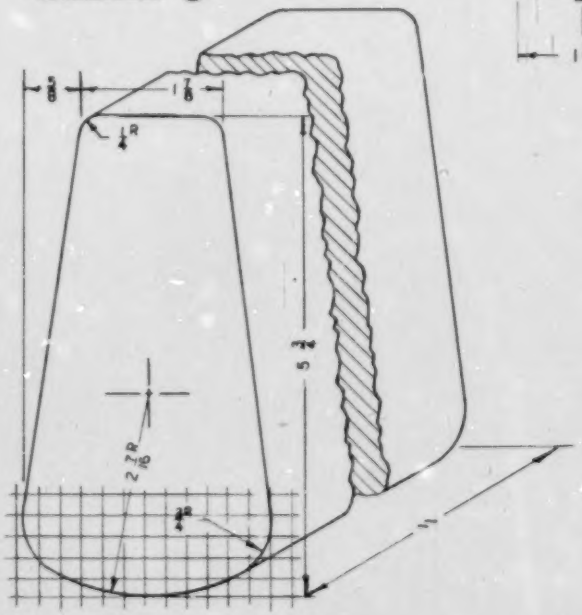
GLUING PAD (2)



CLAMPING FIXTURE (3) (6)



CONTINUOUS FORM (4) 1/4 SQUARES



BENDING FORM (1) 1/4 SQUARES

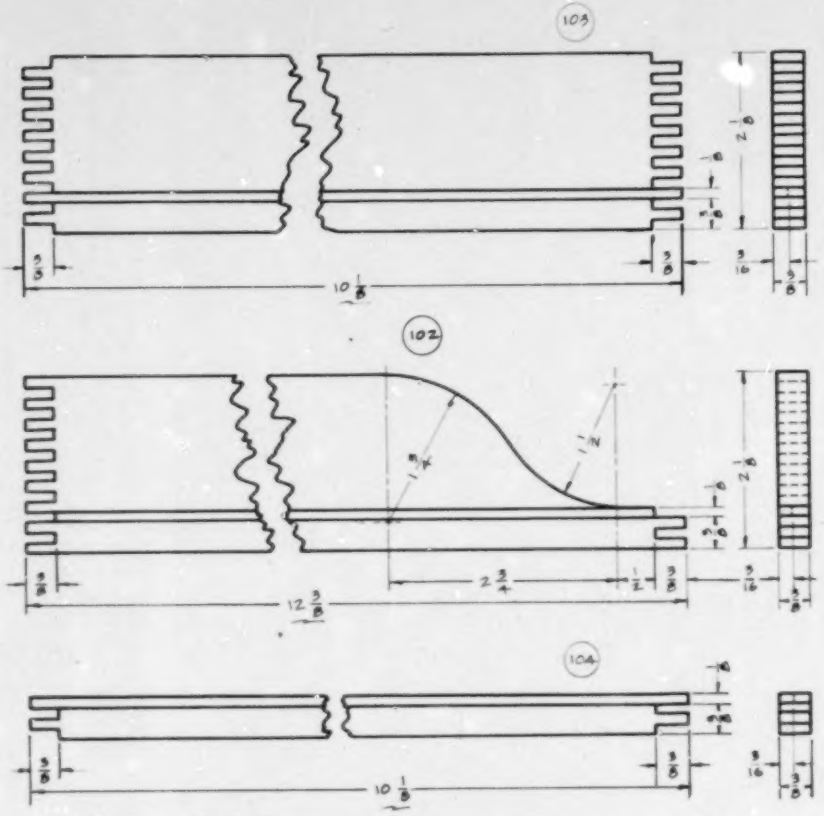
PART NO	NAME	MATERIAL	REQD	CUT OUT SIZE	FINISH SIZE	UNIT BD FT	TOTAL BD FT	UNIT COST	TOTAL COST
7	BASE OR FOOTING VENEER	SELECTED	7	⅛ x 1½ x 7⅛	⅛ x 1½ x 7⅛	.09 55/144	.65 50/144	.01	.09
6	STRIPS FOR CLAMPING FIX	OAK, RED	4	1 x 1½ x 13.0	¾ x 1¼ x 12¾	.14	.56	.07	.28
5	BLANK	VENEER	5	⅛ x 11 x 12¾	⅛ x 11 x 12¾	.95 55/144	4.7 50/144	.13	.66
4	CONTINUOUS FORM	HARD MAPLE	1	2 x 4½ x 6½	1½ x 4 x 6.0	.38	.38	.28	.28
3	CLAMPING FIXTURE	UPHOLSTER WEBBING	3	3½ x 24.0	3½ x 22⅞	1'-5"	4'-3"	.10	.30
2	GLUING PAD	DOUGLAS FIR PLYWOOD	2	¾ x 6 x 12.0	¾ x 5½ x 11	.5	1.0 55/144	.23	.46
1	BENDING FORM	PONDEROSA PINE	1	5PCS ⅜ x 6½ x 12	3 x 5¾ x 11	.58	2.9	.12	.60

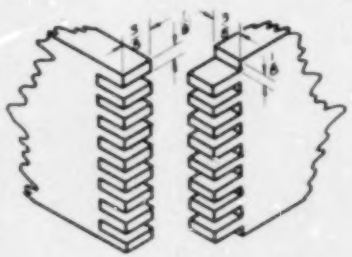
REVISIONS NO	DATE	BY
1		
2		
3		
4		
5		

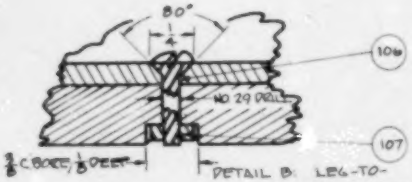
NAPKIN HOLDER
JIGS AND FIXTURES
SOUTHWEST MISSOURI STATE
INDUSTRIAL EDUCATION

DRAWN BY JOHN DUNLAP	SCALE 1" = 1"	MATERIAL 1/28 VENEER	
CHK'D OCO	DATE 12-9-69	DRAWING NO 3 of 3	
APP'D LEON PHIPPS	JOB O DATMAN		

6-1

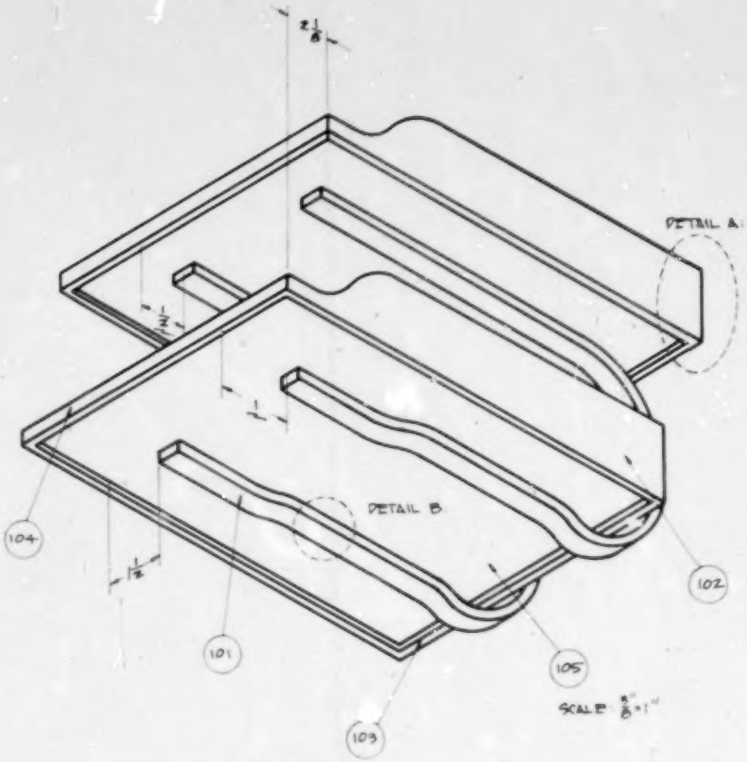



DETAIL A: CORNER FINGER JOINT



DETAIL B: LEG-TO-BOTTOM FASTENING

SCALE 1"=1"



NOTE: EDGES OPTIONAL; ⅛ INCH RADIUS USED ON PROTOTYPE

									TOTAL	9.58
107	SQ NUT	—	—		NO 5-40	8			.01	.08
106	MACH SCR	—	—		NO 5-40 × ⅝	8			.01	.08
105	BOTTOM	HB BOARD	⅛ × 10 × 12¾		⅛ × 9½ × 12	2	0.8896	1.66 SQ'	.22	44
104	FRONT	WALNUT	½ × ¾ × 10⅜		⅜ × ½ × 10⅜	2	.03	.06	.04	.08
103	BACK	WALNUT	½ × 2⅛ × 10⅜		⅜ × 2⅛ × 10⅜	2	1.83	3.66	1.99	3.98
102	SIDE	WALNUT	½ × 2¼ × 12¾		⅜ × 2⅛ × 12⅜	4	0.92	3.68	1.00	4.00
101	LEG	WALNUT	⅛ × 2¼ × 30	14 VEN	½ × 1 × 28 CURVED	2	4.7 SQ'	6.58 SQ'	.07	.92
NO	PART	MATERIAL	ROUGH SIZE	NO REQ	FINISH SIZE	NO REQ	UNIT BD FT	TOTAL BD FT	UNIT COST	TOTAL COST

PRELIMINARY INVESTIGATIONS AND DRAWINGS BY STUDENTS, RONALD JOHNSON, ROGER PELTON, JAMES STRONG, AND JOE SULLIVAN.

IN-OUT PAPER TRAY

SCALE: INDICATED	DRAWING NO. 1 of 2
DATE: 12-17-70	
APP: O. OATMAN	DRAWN BY: J. MOONEY
SOUTHWEST MISSOURI STATE SPRINGFIELD, MO.	

1-10

GENERAL NOTES:

A— SHAPE AFTER DRYING OF 14—$\frac{1}{20}$ VENEER. (LAMINATE)

B— $\frac{5}{8}$ INCH I.D. PIPE, $2\frac{1}{4}$ INCH LONG, FOR REINFORCEMENT.

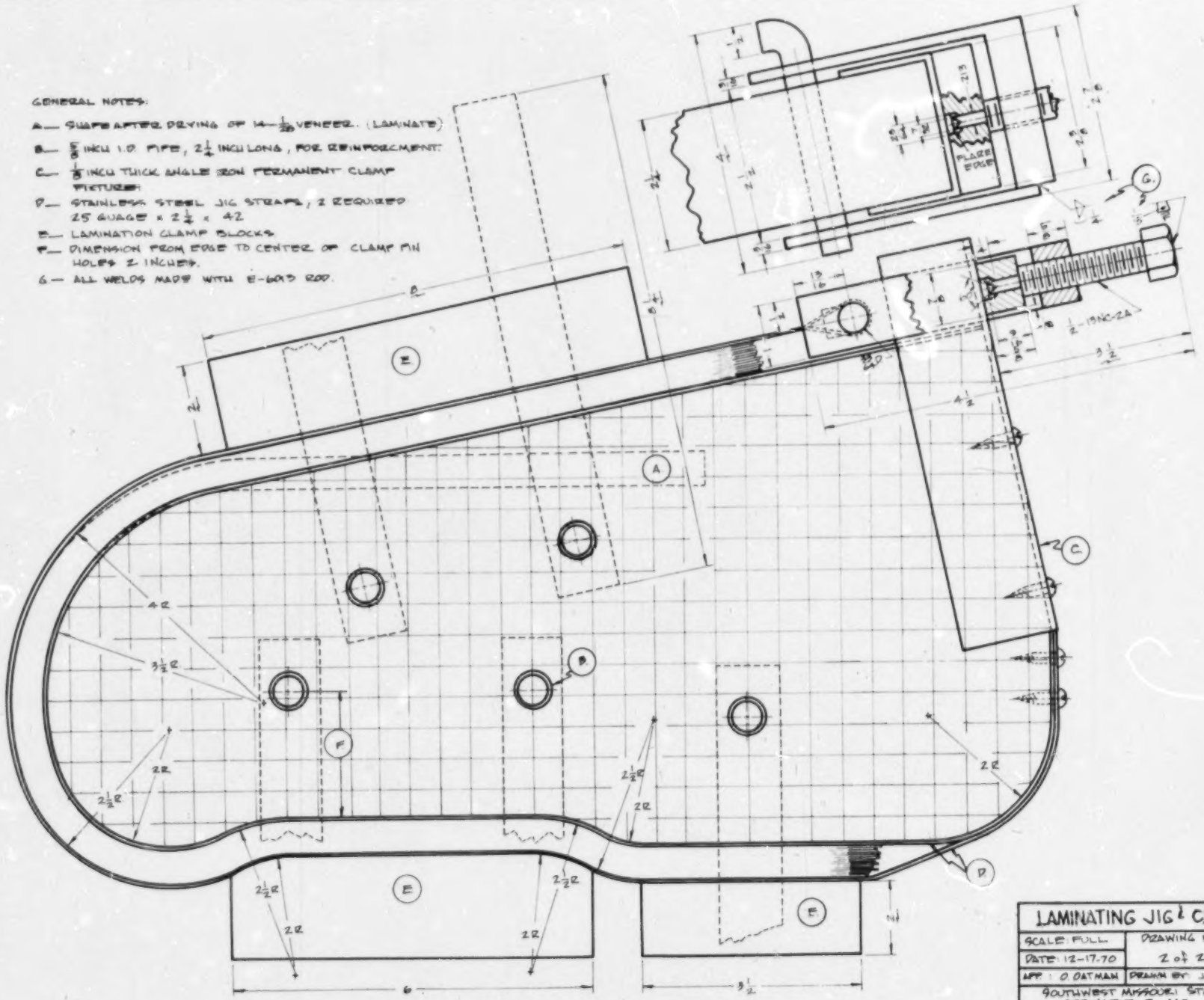
C— $\frac{1}{8}$ INCH THICK ANGLE IRON PERMANENT CLAMP FIXTURE.

D— STAINLESS STEEL JIG STRAPS, 2 REQUIRED 25 GUAGE x $2\frac{1}{2}$ x 42

E— LAMINATION CLAMP BLOCKS

F— DIMENSION FROM EDGE TO CENTER OF CLAMP PIN HOLES 2 INCHES.

G— ALL WELDS MADE WITH E-6013 ROD.



LAMINATING JIG & CLAMP	
SCALE: FULL	DRAWING NO
DATE: 12-17-70	2 of 2
APP: O OATMAN	DRAWN BY: J MOONEY
SOUTHWEST MISSOURI STATE SPRINGFIELD, MO.	

II. PEG DIFFUSION

Polyethylene Glycol, (PEG), properly diffused into green wood will stabilize wood cells, serve as a chemical seasoning agent, suppress decay and yet have slight effect on wood's physical properties, gluing or finishing qualities.

Through extensive research by Forest Products Laboratories, the development of polyethylene glycol treatment as a practical utilization of waste woods has opened up a new field of conservation and marketability of waste tree parts. Burls and crotches of green trees can be used for wood carvings, wood sculpture, bowls, trays, gunstocks and a variety of products limited only by the imagination and ingenuity of the industrial arts students and teachers.

Advantages of working green wood are numerous: the expense and work involved in face-to-face gluing is eliminated, hand and machine tools retain their cutting edges longer, lathe tools stay cooler, dust problems are almost eliminated and expensive native wood is easily obtained by the student for his experimental and laboratory work. In urban areas, material selections can be made by observing where trees are being removed in parks and along streets. In rural areas, choices of selections are more numerous where trees are being cut for stove wood, logs or for land clearance.

A typical PEG product, a lathe turned bowl, can be produced by obtaining a green log or limb section of the desired size. The dimensions of the turned product will be governed only by the lathe, face plate, methods of treatment and safety limitations used in turning.

Saw one end of the green stock square and secure to a face plate with wood screws. Shape the exterior of the bowl contour, scrape out the interior leaving a wall thickness of 3/8 to 1/2 inch thick. Remove the rough turned bowl from the face plate and soak in PEG solution at room or elevated temperatures. Soaking time schedule is determined by concentration and temperature of the chemical, size and thickness of wood species.

Remove rough product from the treating chemical and dry by open-air or kiln methods. One inch thick walnut, dried by the open-air method, inside an industrial arts laboratory, will reach an equilibrium moisture content (EMC) of 6-8 percent in 9-10 days. Utilizing a kiln such as the Automatic Drying Chamber, at a temperature of 140 degrees F., the EMC can be reached in 60 hours or 2½ days. Secure the dry, rough turned bowl to a lathe face plate and machine the walls to 1/8 or 1/4 inch thickness. The bottom dimension will be determined by the method used to secure the product to the face plate. Walls of treated bowls, 8 inches in diameter, have been successfully turned and rough sanded to a cross section of 1/16 of an inch. Finish sanding and apply either a surface type polyurethane varnish, or use Danish oil if a soft-toned natural finish is desired.

36" Diameter White Ash Disk, Control [left] and PEG Cold Treated Disk [right] [Fig. II-1]

Polyethylene glycol (PEG) is a chemical, wax-like substance produced from natural gas which is soluble in water at only slightly elevated temperatures of 104 degrees F. PEG materials are designated by a number that roughly represents the average molecular weights. The 200 through 600 PEG numbers are clear liquids, whereas the 1,000 through 6,000 numbers are white, waxy solids. After extensive experimentations PEG-1,000 has been recommended as best adapted for stabilization of green wood used in industrial arts laboratories.

Diffusion of PEG into the green wood cells is not just a matter of filling the cavities or lumens of the tube-like cells with the chemical but also the diffusing of the stabilizing agent into the cell wall structure. The natural moisture of the enlarged or swollen wood cells is replaced by the molecules of the stabilizing agent. This 'bulking' of the cell walls and cavities restrains the shrinking of green wood as it dries and the swelling of dry wood when it is exposed to damp conditions (Fig. 11-1).

To achieve the minimum amount of shrinkage, it is necessary to diffuse PEG into the wood in an amount equal to 30 percent (25-30 percent is fiber saturation point of most woods) of the dry weight of wood. If it were necessary to replace all the moisture (some woods contain 300 percent moisture) with a bulking agent the cost would be prohibitive. Normal shrinkage and swelling of PEG treated woods, at the two extremes of relative humidity, can be reduced by more than 82 percent. The ratio of tangential to radial shrinkage or swelling is unaffected by this bulking treatment.

PEG Thermo Tank [Fig. II-2]

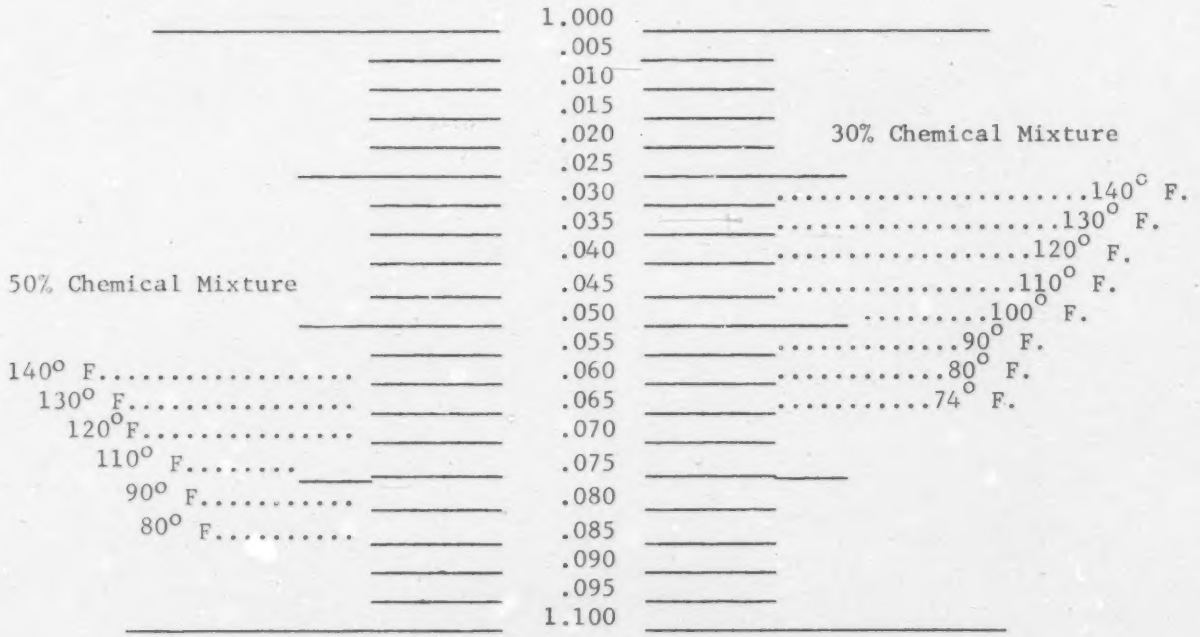
Green wood selected for PEG treatment should be sealed in plastic bags or immersed in water to prevent checking and splitting until they can be stabilized in PEG solutions. Common mixtures used are 30 percent by weight and/or 50 percent by weight. A plywood or fiberboard box of the exact size required and lined with a sheet of heavy plastic will make an excellent 'one-shot' soaking vat. Metals other than stainless steel containers should be avoided. If a permanent soaking container is desired that utilizes elevated temperatures and automatic heat controls, the drawing and procedure for construction of the PEG Thermo Tank has been included for your study and consideration (Fig. II-2).

PEG treating or soaking time will vary with the density of the wood selected. Walnut is a medium density wood that averages about 0.55 in specific gravity on a green volume, dry weight basis. Lower density softwoods such as white pine, spruce, redwood and the 'soft' hardwoods as soft maple, cottonwood and willow should soak for about half the time suggested for walnut. For higher density woods like hard maple, yellow birch, beech, cherry, the oaks, and applewood, double or triple the treating period. Elevated temperatures are normally required for fully effective treatment of very dense woods such as mesquite, desert ironwood, myrtlewood and burls of most all species.

The treating schedules shown in the following table are based upon experience with walnut.

Solution concentration and temperature	Suggested period of soak for:	
	Walnut disks up to 9 inches in diameter and 1 to 1½ inches thick	Walnut disks over 9 inches in diameter and 2 to 3 inches thick
30 percent, 70°F	20 days	60 days
50 percent, 70°F	15 days	45 days
30 percent, 140°F	7 days	30 days
50 percent, 140°F	3 days	14 days

The following graduations of a hydrometer scale, used to check specific gravity of the chemical PEG, have been calibrated in a laboratory type situation to aid in determining mixtures and soaking schedules. The low end of the scale does not conform to item 1 in the procedure: 'Operating Instructions for PEG Thermo Tank'.



Balance of scale has been cut off for brevity

Drying of the treated wood can be accomplished by stacking the wood, separated by dry stickers, under cover in a well ventilated room or building, perferably one that is heated in the winter. Air drying time will vary with the thickness of the wood treated, temperature and relative humidity of the area. If a dry kiln is available, well treated wood can be dried rapidly under rather drastic conditions without danger of splitting. If the Automatic Drying Chamber is used, No. 1 drying sequence is recommended with a heat setting of 140°F. This sequence allows the fan to circulate chamber air when the heating elements are activated.

Finish machining, working or application of a finish can be continued on the wood when an EMC has been reached. Treated PEG woods can be glued by using casein, cold-setting urea, resorcinal and/or epoxy adhesives. For best results, the surface of the treated wood to be glued should be wiped with toluol and then alcohol before the adhesive is applied.

Workability of PEG treated woods actually machines better than dry wood and to closer tolerances without danger of chipping. When sanding, the PEG chemical tends to clog the finer grits of abrasive paper making it necessary to use a coarser abrasive grit than is normally used.

Darkened surface areas can be bleached with a dilute solution of oxalic acid or a commerical bleach to bring out the natural color of the wood. Bleaching will also accentuate the contrast between heart and sapwood of most species. Recommendations of the manufacturer should be followed as to neutralizing the bleach before continuing with the finish sanding.

Before the final sanding operations, abrasive work can be made easier by wiping the stock with a rag soaked in alcohol. This process tends to remove the chemical on the surface. Final abrasive work

prior to application of the finish can be accomplished with wet-or-dry abrasive paper, 4/0 or 150 grit, using hot water as a lubricant. Allow the wood to dry thoroughly before proceeding with either a polyurethane resin-base varnish or Danish oil finish. These finishes have proven satisfactory over the waxy surface of PEG treated woods.

If a toner or stained filler is to be used, allow at least 24 hours for drying. Sand the dried filler with 220 grit abrasive before application of the 1st full strength finish coat of polyurethane resin-base varnish. Apply as many coats as desired, sanding between applications with 220 grit abrasive paper or 4/0 steel wool. After the final coat has dried thoroughly, rub out the finish with pumice or rotten stone using oil as a lubricant. If Danish oil is used follow manufacturers recommendations for application. Further protection may be achieved by applying furniture polish or wax over the varnished surface. Use Danish oil wax over the oil finish.

Procedure for Construction of PEG Thermo Tank

1. Carefully study drawing for dimensions and plywood cutting schedule.
2. Crosscut sheet of plywood to finish length of front and back panels.
3. Crosscut to finish length stock for end panels.
4. Rip these two pieces to squared finish dimensions, discounting the width of the saw kerf.
5. Rip wedge shaped support and square the pointed end to finished dimension.
6. Secure support, in step 5, to the edge of front component with scrap stock to use as a guide against saw fence when cutting diagonal dado.
7. Repeat step for dado cut on back component. Note that this dado will be cut in the opposite direction.
8. Saw dado cuts on height dimensions of end components to receive front and back panels.
9. Make enclosed dado cuts on end components to receive bottom. Care must be taken not to cut through the vertical dado cuts. Clean out remaining stock with wood chisel.
10. Square bottom to finish dimensions or to fit inside dado cuts.
11. Use clamps and or nails to secure components 1 through 6 in trial assembly.
12. When tank is squared in trial assembly, drill pilot holes for flat head wood screws through the fitted joints. All screws should be spaced 6 inches on center.
13. Drill shank holes and countersink.
14. Secure screws, release clamps and pull nails used in trial assembly.
15. Cut and fit vertical corner reinforcement blocks.
16. Cut and fit hinge board for top.
17. Disassemble tank components.
18. Mix waterproof or water resistant adhesive for final assembly.
19. Secure tank with screws and adhesive. Nail and glue corner blocks. Check and adjust tank for squareness.
20. After the fiberglass has been applied to parts 1-4 and 6, the correct inner top spacing or clearance can be accurately calculated for the top assembly.
21. Square to finished dimensions inner and outer top, trial assemble, test for proper closing clearance and assemble with nails or screws and adhesive.
22. Secure mounting plate to heating element, lay out position and cut opening through the end of tank; trial assemble unit with mounting bolts.
23. Lay out position, cut opening through front of tank for thermostat transfer plate and trial assemble unit with mounting bolts.
24. Apply fiberglass cloth and resin to the inside surfaces of top, position hinges and fit top to tank.
25. Remove heating element mounting plate and thermostat transfer plate, apply fiberglass resin to inside surface of tank and bolt holes, secure plates into position. Follow correct procedure for application of fiberglass cloth and resin, cover inside of plates for complete waterproofing of heating element mounting plate and thermostat transfer plate.
26. Position and wire thermostat, power switch, pilot light, heating element and connect power lead.
27. Fabricate, position and secure covering for control panel electrical components.

28. Test PEG Tank with 60 gallons of water to insure that it is watertight. With 60 gallons of liquid the heating element will be covered with 13 inches of fluid allowing an air space of 2½ inches below the top.
29. An optional component can be fabricated from stainless steel to protect the interior heating elements from samples being treated.
30. Connect lead to power supply and adjust thermostat to desired setting. Check watertightness of tank and electrical connections for an adequate length of time before sealing control panel and painting tank. PEG Thermo Tank can be mounted on a rolling platform if desired.

Procedure for Covering PEG Thermo Tank with Fiberglass

1. Allow a minimum of 3½ hours to complete the first stage of fiberglassing.
2. Sand and wipe clean surfaces to be covered.
3. Voids in wood should be filled with a thick mixture of resin and catalyst.
4. Cut fiberglass cloth to rough size allowing at least 1 inch lap over each covered section. Suggested pieces would cover: bottom and ends, side, side, inside, or lower part of top.
5. Measure approximately one quart of resin, add 10-15% styrene monomer, add 1% catalyst and mix thoroughly. Note: As soon as catalyst is added, curing begins; work as rapidly as possible.
6. Apply soak coat. Brush or roll on the mixture being sure to cover the entire surface and top edges of the tank.
7. Allow the soak coat to gel.
8. The gel or second coat may now be applied. Mix approximately 1 quart of resin and catalyst, stir thoroughly. Allow proper drying time for all prepared resin applications.
9. Brush or roll on the resin-catalyst mixture.
10. Allow 2nd coat to gel for approximately 10 minutes; a tacky surface will hold the cloth.
11. Apply fiberglass cloth in any organized manner, sides first with ends and bottom overlapping has worked satisfactorily.
12. When cloth is placed over the gel coat, start from one side and work the air out as the cloth is laid into the gel coat.
13. Mix approximately one quart resin and 1% catalyst and apply third application.
14. Brush or roll the resin over the cloth making sure that all bubbles are worked out and that the cloth is saturated.
15. If cured resin develops bubbles, sand or remove with sharp edge tool, patch with cloth if necessary and apply as many coats as required to provide a smooth surface.
16. Trim off any cloth overlapping edges or corners that has not smoothed down.
17. Runs, folds and sags may be sanded out as desired.
18. Wet sanding with waterproof paper gives a smooth, even surface.
19. Top, heating element mounting and thermostat transfer plate can be fiberglassed in the same manner as the inside of the tank.

Operating Instructions for PEG Thermo Tank

1. Test the percentage of tank mixture with a hydrometer. 30% solution will have a specific gravity of 1.05 at 60°F., at 140°F. the specific gravity reading will be 1.03. 50% solution will have a reading of 1.093 at 60°F., at 140°F. the reading will be 1.06. If the PEG solution is not of the desired concentration, add water or chemical as needed.

2. Wear rubber gloves to protect the hands from the waxy solution. Load the green wood, disc, carvings, turnings, blanks, or etc., into the solution. Stainless steel rods or narrow strips of wood placed between the various items and the bottom of the tank will permit circulation of the solution. Weights should also be used to prevent pieces from floating to the surface. Close and lock the tank lid.

3. Plug power cord into the receptacle; the 220 volt attachment plug should have a locking position to aid in retaining power connection.

4. Turn the safety disconnect switch to ON position; the pilot light located above the switch should glow.

5. The period of soaking time needed to obtain sufficient penetration of PEG into the wood depends upon the concentration and temperature of the treating solution, the size, thickness of wood, and species. Diffusion of the chemical, polyethylene glycol, can be accelerated by increasing the temperature and also the concentration of the solution.

6. Position thermodisc to desired heat setting. The time allowed to reach selected setting will vary as to amount of solution in the tank and the percentage of mixture.

7. When the pilot light switches off you may want to test the specific gravity of the solution at the elevated temperature. TURN OFF THE SAFETY DISCONNECT SWITCH before opening the tank lid. Record the temperature and hydrometer readings at this time. Adjust the concentration of the solution if needed. Exactly 4.46 pounds of PEG dissolved in 5 quarts of water will make 7 quarts of 30% solution. 10 pounds of PEG dissolved in an equal weight of water (about 4.8 quarts) will make about 7.4 quarts of 50% solution.

8. Close and lock the tank lid, turn on the safety disconnect switch to continue diffusion process.

The following articles, bulletins and references have been selected to give you a variety of techniques, processes and information.

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Frost, Honor. 'Punic Ship Found.' *Compressed Air*, Vol. 78, No. 3, March, 1973, pp. 12-13.

Hoadly, R. Bruce. 'PEG-1000.' *Workbench*, Vol. 28 No. 2, 1972, pp. 48-49.

'How to Make it with PEG.' 1972, the Crane Creek Co., P.O. Box 5553, Madison, Wisconsin 53705.

Leslie, Harry C. 'PEG ot the Woodworkers Heart.' *Man Society Technology, A Journal of Industrial Arts Education.*, Oct. 1973, pp. 13-16.

Magnuson, Karen Lee. 'How to Work with Green Wood.' *Popular Science*, Volume 200, No. 4, 1972, pp. 146-148.

Merz, R.W., and G.A. Cooper, 'Effect of Polyethylene Glycol On Stabilization of Black Oak Blocks.' *Forest Products Journal* Vol. 18, No. 3, March, 1968, pp. 55-59.

Mitchell, Harold L. ''Beat the High Cost of Walnut Turning Blocks.'' *School Shop*, January, 1974, pp. 40-41.

Mitchell, H. L. 'How PEG Helps the Hobbyist Who Works With Wood.' Forest Products Laboratory, Forest Service, U.S. Dept. of Agriculture, Madison, Wisconsin 53705.

Mitchell, Harold L. 'Using Cross Section of Green Logs or Limbwood for Wood Projects.' *School Shop*, January, 1965, pp. 20-21.

Pankowski, Dallas. 'Stabilize Green Wood for Turning and Carving.' *School Shop*, June, 1965,pp. 40-41.

'PEG is the Sweetheart of the Wood Craftsman.' *U.S.D.A. Yearbook of Agriculture: Science for Better Living*, 1968, pp. 147-149.

'Plastic Chips.' *Bulletin and Catalog*, Cope Plastics Illinois, Inc., 1111 West Delmar Ave., Godfrey, Ill. 62035.

'Stabilization of Hard Maple Flooring with Polyethylene Glycol 1000,'. USDA Forest Service Paper, FPL 187, 1972.

Steele, Gerald L. *Fiberglass Projects and Procedures.* McKnight & McKnight Pub. Co., Bloomington, Ill., 1962.

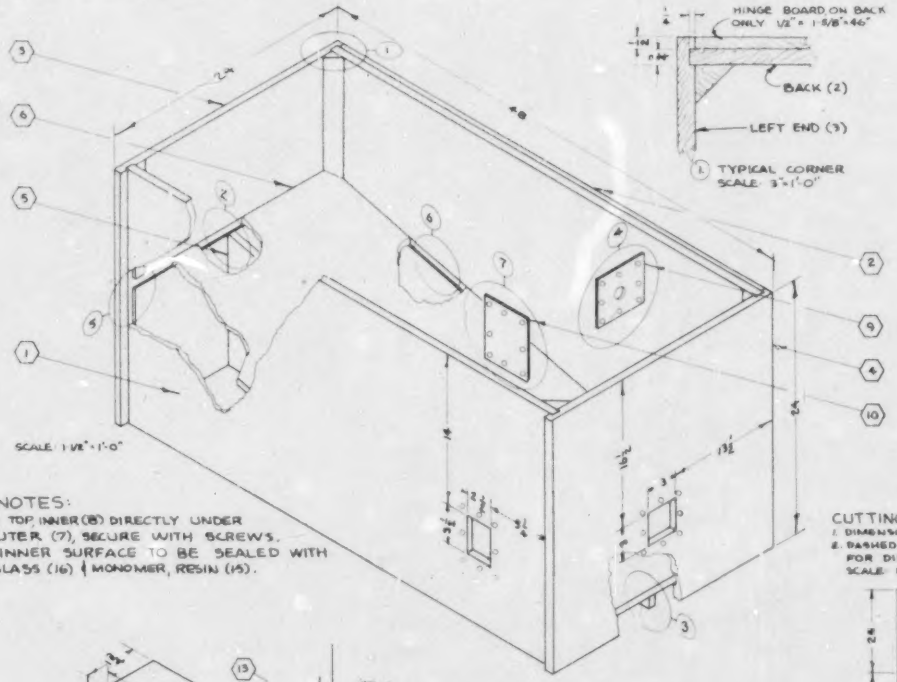
Swanson, Richard A., and Patrick K. Lavan. 'Polyethylene Glycol Wood Stabilization Tank.' *School Shop*, January, 1969, pp. 36-37.

PEG supplies can be obtained from the following companies.

Albrecht, Robert M., 8635 Yolanda Ave., Northridge, California 91324.

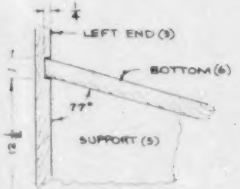
Crane Creek Company, P.O. Box 5553, Madison, Wisconsin 53705.

Wilkens-Anderson Company, 4525 West Division St., Chicago, Illinios 60651.

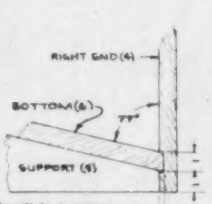


SCALE: 1 1/2" = 1'-0"

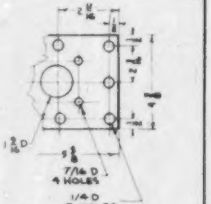
1. TYPICAL CORNER SCALE: 3"=1'-0"



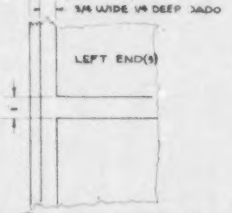
2. LEFT END DETAIL SCALE: 3" = 1'-0"



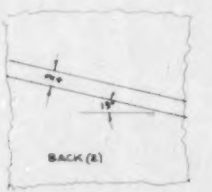
3. RIGHT END DETAIL SCALE: 3" = 1'-0"



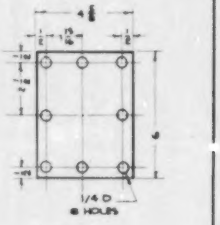
4. ELEMENT MOUNTING (9) SCALE: 3"=1'-0"



5. TYPICAL DADO CUT (EACH END) SCALE: 3" = 1'-0"



6. TYPICAL DADO CUT (EACH SIDE) SCALE: 3" = 1'-0"



7. HEAT TRANSFER PLATE SCALE: 3" = 1'-0" (10)

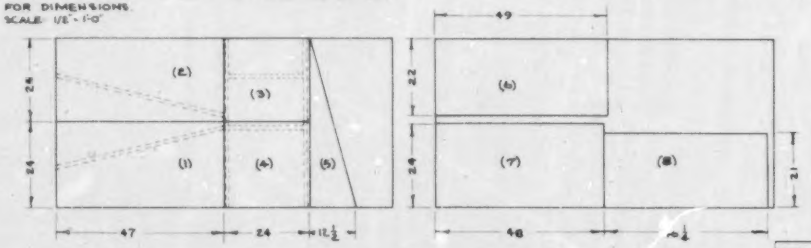
TOP NOTES:

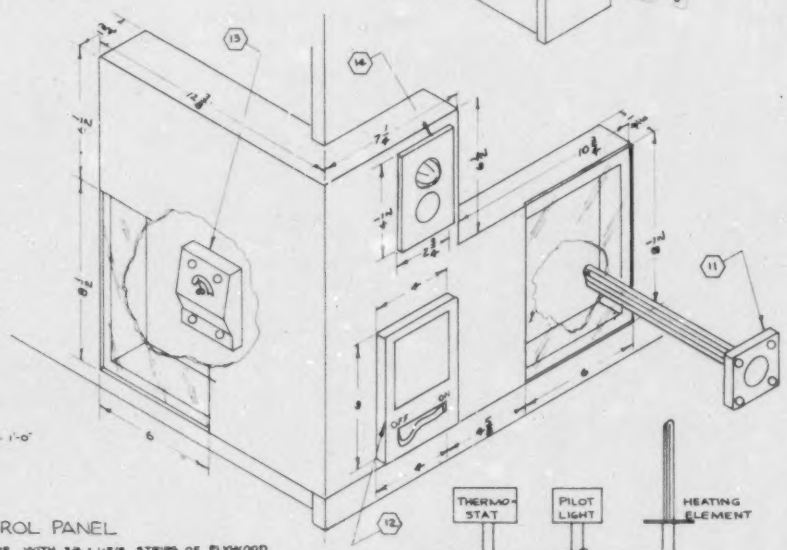
CENTER TOP INNER (8) DIRECTLY UNDER TOP, OUTER (7), SECURE WITH SCREWS. TOP'S INNER SURFACE TO BE SEALED WITH FIBERGLASS (16) & MONOMER, RESIN (15).

CUTTING NOTES

1. DIMENSIONS SHOWN ARE ACTUAL NEEDED FOR CONSTRUCTION.
2. DASHED LINES INDICATE DADO CUTTING, SEE DETAILS FOR DIMENSIONS.

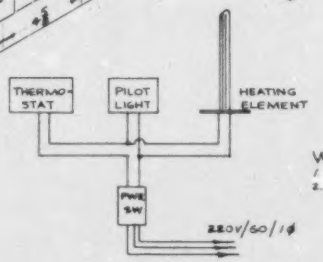
SCALE: 1/2" = 1'-0"





CONTROL PANEL

1. FRAME WITH 3/4 x 1-5/8 STRIPS OF PLYWOOD.
2. COVER WITH 1/8" SHEET HARDBOARD.
3. ACCESS PANELS 1/8" x 8-1/2" x 6" PLEXIGLAS.
4. COVER AND ACCESS PANELS SECURED WITH #8 SCREWS.
5. ALL TOP AND SIDE JOINTS SHOULD BE CHALKED TO PREVENT SOLUTION FROM ENTERING ELECTRICAL COMPARTMENTS.



PART NO	NAME	MATERIAL	REQD	CUT OUT SIZE	FINISH SIZE	UNIT SQ FT	TOTAL SQ FT	UNIT COST	TOTAL COST
								TOTAL	91.78
16	FIBERGLASS CLOTH - VOLAN FINISH, CHROME, SINGLE WT. 40" x 108"								6.30
15	STYRENE MONOMER, 1 GAL., POLYESTER RESIN, 1 GAL.; LUPERSOL (DDM) CATALYST, 2 OZ.								11.65
14	PILOT LIG HT & COVER	230 V, 4"-4" ELECT UTILITY BOX	1 EA						4.16
13	THERMOSTAT	120°-170°F, 6250W, 250VAC, 25A	1	ELECTRIC WATER HEATER					6.01
12	POWER SWITCH	DPST, 230 VAC	1						11.88
11	HEATING ELEMENT	230 V, 4500 W	1						8.25
9 10	MOUNTING/TRANSFER PLATE	STAINLESS STEEL 18GA.	1 EA		SEE DETAIL 4 & 7		.60		1.25
8	TOP, INNER	EXTERIOR PLYWOOD *	1		3/4 x 22 x 46-1/4		7.18		3.59
7	TOP, OUTER	EXTERIOR PLYWOOD *	1		3/4 x 24 x 48		8.00		4.00
6	BOTTOM	EXTERIOR PLYWOOD *	1		3/4 x 22 x 49		7.49		3.75
5	SUPPORT	EXTERIOR PLYWOOD *	1		3/4 x 12-1/2 x 48		2.15		1.08
4	RIGHT END	EXTERIOR PLYWOOD *	1		3/4 x 24 x 24		4.00		2.00
3	LEFT END	EXTERIOR PLYWOOD *	1		3/4 x 24 x 24		4.00		2.00
2	BACK	EXTERIOR PLYWOOD *	1		3/4 x 24 x 47		7.83		3.92
1	FRONT	EXTERIOR PLYWOOD *	1		3/4 x 24 x 47		7.83		3.92

* MARINE PLYWOOD MAY BE USED IN LIEU OF EXTERIOR.

WIRING NOTES:

1. USE #14-3 220 VOLT WIRE.
2. PILOT LIGHT MUST BE IN PARALLEL WITH HEATING ELEMENT.

PRELIMINARY INVESTIGATIONS AND DRAWINGS BY:
HERB CHALLBERG, WAYMAN L KING

POLYETHYLENE GLYCOL P.E.G. THERMO TANK

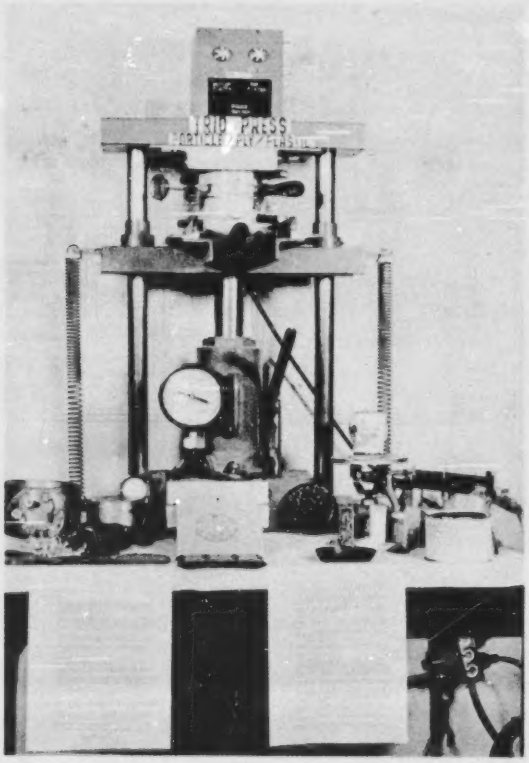
SCALE: AS SHOWN	REVISIONS	BY	DATE
DATE: 7-17-70			
DR: JCD CH: OCO			
APP: "BATMAN"			
TITLE: SOUTHWEST MISSOURI STATE INDUSTRIAL EDUCATION		NO. 1 OF 1	

III. WOOD FLOUR AND/OR PARTICLE MOLDING
TRIO PRESS - PARTICLE, PLY AND PLASTIC

An important area of research today is in the design of products manufactured or produced from wood waste. Wood industries have an enormous loss each year not only in wood remnants but in money required for its disposal. Research in the area of wood waste has led to the production of various pulp, particle and chip core products. Wood wastes can also be utilized as roughage in livestock feed. Possible the newest product developed by Weyerhaeuser Company is molded surface skins for hollow-core colonial style panel doors. The list of products manufactured from wood waste is expanding and can be seen as a rising new industry.

Wood industries are constantly researching and experimenting in this important area of reconstituted wood. Industrial arts programs in junior and senior high schools, Level I-IV, should also conduct research and experiments in this vital area. This process, wood flour and particle molding, offers an opportunity to use available waste from a woods laboratory to demonstrate an industrial process on a reduced scale. Wood flour molding will introduce students to production methods and procedures similar to those used in industry. Additional experience could also be gained in the areas of product and tool design, pattern-making, foundry, metals, electronics, and wood technology. These areas and others will be touched upon by the student when he designs a product, fabricates the pattern, ram-up and casts the mold in the foundry, machine the casting in a metals area, figure tolerances necessary for the die, calculate percentages of resin and wood flour, degree of heat and amount of pressure required to produce the product of his own design.

The industrial arts teacher can fabricate or supervise Level III or IV students in assembling this molding unit (Fig. III-I) in his industrial arts laboratory with assistance from plans and information furnished. The cost will vary as to the size of the dies and press selected by the industrial arts instructors to fit their own particular situation.



Trio Press Molding Unit [Fig. III-I]

Construction Procedure
for Trio Press, and Accessories

I. Heat Platen(s).

1. Obtain ½ inch aluminum plate (If 1 inch plate or a cast aluminum disc is used omit steps 3-5).
2. Cut stock to rough size.
3. Layout, drill, and tap holes to secure stock face to face.
4. Countersink holes for flat-head machine screws.
5. Secure pieces surface to surface with ¼ x 20 NC screws.
6. Layout and drill holes for heat elements and thermoswitches.
7. Construct chucking face plate to be bolted to platens.
8. Bolt chucking face plate to platens and center in 4-jaw lathe chuck.
9. Machine platens to diameter.
10. Cut keyways for aligning pins on switches.

II. Heat Platen Holder(s).

1. Obtain 1½" steel plate, hot or cold rolled steel. (Cast-aluminum holders can also be used to to reduce cost.)
2. Remove scale from surface by surface grinding if necessary.
3. Mill to size as specified.
4. Position stock in 4-jaw lathe chuck.
5. Machine space to receive heat platens.
6. Remove stock from chuck.
7. Layout all holes to be drilled.
8. Drill holes.
9. Tap necessary holes.
10. Surface grind if needed.

If heat platens are not desired, the heat elements may be installed in the die, thereby heating it directly instead of by heat transfer. If the heat element is designed into the die, a disc element would possibly be more practical. Disc element, Chromalox Catalog #67, HSP-31, with 3 ¼" outside diameter, 5/16" thickness, 120 volts and 400 watts is recommended.

DIES

The dies used in this process may be machined from cold rolled steel, cast iron, or cast aluminum. The two most practical metals are cold rolled steel and cast aluminum. Cold rolled steel will give a good quality die that may be chrome plated or used with a polished surface. Aluminum dies may be cast in a foundry and machined to size. Aluminum dies usually have a porous surface finish which means a parting agent must be used or the dies coated with an industrial grade of teflon. All dies should be designed so that available machines can be used.

The use of a type of investment casting to produce dies with smooth surface characteristics and little or no machining is a possibility in the industrial arts laboratory. Investment casting uses plaster molding powder instead of sand to contain the wax pattern. A simple explanation of the process is: a wax pattern is fabricated with sprues, risers, and gates attached; a flask is set up around the pattern and a fluid plaster composition is poured around the pattern which is suspended in the flask by the sprue, risers, and gates; after the plaster has set-up the wax is melted out and the molten metal desired is poured into the mold. Wood patterns may also be used, but special pattern procedures must be employed.

Die and Plunger for Discs

III. Die

1. Turn wood pattern.
2. Ram up sand molds in foundry area.
3. Pour molds and let stand for 24 hours.
4. Clean casting.
5. Position casting in 4-jaw chuck.
6. Machine casting as specified on drawing.
7. Turn casting end for end in chuck and machine rough portion.
8. Remove casting from chuck.
9. Layout and drill holes for knock out pin.
10. Machine knock out pin.
11. Layout and drill holes for hold-down pins and thermometer.

IV. Plunger

1. Turn wood pattern.
2. Repeat steps 2 through 8 in section III above.
3. Layout and drill holes for hold down pins and thermometer.

Charging Chamber, Coaster Die, and Plunger

1. Obtain one piece of 1020 cold rolled steel 5'' dia.x7''.
2. Cut rough size pieces for charging chamber, die, and plunger.

V. Charging Chamber

1. Position stock in 4-jaw chuck.
2. Face stock and machine to not under 4.875 inch diameter for at least 1.125 inches length.
3. Machine 4 inch diameter hole through stock.
4. Machine angle on inside of machined hole as indicated.
5. Remove from 4-jaw chuck.
6. Cut off excess material.
7. Position stock in 3-jaw chuck.
8. Face stock to 1 inch length.
9. Machine edge as specified on drawing.
10. Drill 3/16 inch hole as noted.
11. Cut slot as shown on drawing.

VI. Die

1. Position stock in 4-jaw chuck.
2. Face stock and machine outside diameter the same size as the charging chamber.
3. Remove stock from chuck.
4. Position machined end of stock in 4-jaw chuck.
5. Face stock and machine to diameter.
6. Machine lip as specified on drawing.
7. Machine rough concave form of coaster.
8. Finish machining concave form of coaster.
9. Polish surface for desired finish.
10. Remove stock from chuck and layout holes to be drilled.
11. Drill holes for thermometer and hold down pins.

VII. Plunger

1. Position stock in 4-jaw chuck.
2. Face end, machine to diameter.
3. Turn stock end for end in chuck.
4. Machine stock to shape and size as specified.
5. Polish surface for desired finish.
6. Remove stock from chuck.
7. Layout and drill holes as specified.

Hold Down Pins for Dies and Platens

VIII. Hold Down

1. Obtain 2 pieces of one inch square cold rolled steel 5 inches long.
2. Position stock in 4-jaw chuck and machine pin.
3. Repeat step 2 for each end on stock.
4. Mill both pieces of stock to specified thickness.
5. Cut both pieces in half to get the four hold downs.
6. Drill 7/16 inch holes for slot, mill slot.
7. Surface grind if desired.

Pressure Platens for Plywood and Lamination Blanks

IX. Platens (Details not shown on drawings)

1. Obtain ½ inch aluminum plate (If 1½ plate or cast aluminum plate is used omit steps 3-5).
2. Cut stock to rough size. Finish dimensions of platens are 1½"x7"x7".
3. Lay out, drill and tap holes to secure plates surface to surface.
4. Countersink holes for flat-head machine screws.
5. Secure pieces surface to surface with ¼x20NC screws.
6. Square platens to finished size.
7. Lay out and drill holes for thermometers. Holes should be ¼" from top surface, centered and of sufficient depth to obtain correct temperature of platen when in use.
8. Bolt 2 strap hangers, 1/8"x3/4" to each pressure platen to aid in attaching to heat platen.
9. Bolt stainless steel sheets to sides and back of bottom pressure platen overlapping top pressure platen. This assembly will aid in holding veneers set up for plywood or laminated blank.
10. Square 2 pieces of 16 gauge stainless steel sheets to 6 7/8" to serve as smooth plate blanks.
11. Polish surface for desired finish.

Press Components

X. Top Support and Base

1. Obtain all materials necessary for components in sections X through XV.
2. Lay out positions for cross and parallel braces and or bars in channels.
3. Tack weld braces in their respective positions.
4. Lay out the position of the guide rod holes.
5. Position channels back to back, clamp securely.
6. Drill holes for guide rods.
7. Insert bolts through guide rod holes, secure channels together by drawing up nuts; this will insure alignment after welding.
8. Weld braces and bars. Use skip welding sequence to minimize warpage.
9. Lay out spring supports and drill holes for springs.
10. Weld spring supports into position.
11. Position and weld support feet in position.

XI. Sliding Platform

1. Lay out position of pressure plate reinforcement.
2. Tack weld into position.
3. Lay out and mark center for sleeves.
4. Scribe circle of the proper diameter for sleeves.
5. Saw out or burn slots for sleeves.
6. Lay out positions of spring arms, drill holes for springs, tack weld in position.

7. Lay out, drill and tap holes in channel for die and platen slides. Insert screws in holes to keep weld splatter out.
8. Clamp assembled components to top or base support to minimize warpage when welding. Use skip-welding sequence.

XII. Sleeves and Collars

1. Secure rod and or pipe in 3-jaw chuck of metal lathe.
2. Drill, bore or machine to finished inside dimensions.
3. Lay out and mark centers for set screws in collars.
4. Drill and tap holes for set screws.

XIII. Guide Rods

1. Square ends of rods.
2. Mark center for holes to be drilled in rods.
3. Drill and tap holes.

XIV. Die and Platen Slides

1. Square to finished length.
2. Position and weld stops on ends of slides.
3. Lay out holes of correct size to allow varied width assembly of slides.

XV. Construct Holder for Stop Watch

XVI. Assembly of Press

1. Assemble sleeves and collar in sliding platform.
2. Secure slides to sliding platform.
3. Bolt top support and base to guide rods.
4. Secure wood block to base.
5. Secure holder for stop watch.
6. Insert ends of springs in supports.
7. Secure hydraulic jack in position on wood base.

XVII. Assemble control panel and secure in position.

XVIII. Assemble heat platens with heat elements and thermoswitches. Position heat platens in press. Complete wiring to control panel and test wiring assembly.

XIX. Secure die, charging chamber and plunger to heat platens secured to sliding platform and top support. Insert thermometers in die and plunger, plug in power lead, turn on power and platen switches and test run press.

Preparation of Wood Flour and/or Particle Mixture for Molding

1. Prepare wood flour or particles on jointer, surfacer, or saw from stock having correct moisture content, 6-8%. If material is collected from sawdust or particle bin, tests should be made in samples for correct moisture content.

2. Sift particles through screens to obtain size desired (size of screen suggested, from 20 to 140 mesh).

3. Weight the amount of wood flour and or particles.

4. Determine the amount of resin, 30% to 50% content.

5. Place wood particles and resin in container, tumble for 20-25 minutes to mix thoroughly. Add pieces of wood in container to aid in the mixing process.

6. Determine amount needed for product (55 grams for test disc or 47 grams for coaster, amounts can vary as to density desired in product.).

7. Weigh amounts needed.

I. WOOD FLOUR AND PARTICLE MOLDING OF COASTERS

Procedure:

1. Plug powercord into receptacle, turn on center power switch. Turn on top and bottom heat platen switches. Insert thermometers in die and plunger. Preheat to 275 deg. F. (Required time for selected heat is 30-45 minutes. To increase heat, turn thermoswitch center stem counter-clockwise; to decrease, turn clockwise.)

2. When die, charging chamber and plunger has reached preset temperature, release presure on hydraulic jack to allow die and charging chamber to be drawn clear of plunger. If lettering or a trade mark is desired on the product, coaster or disc, a magnesium plate can be etched and inserted in the die at this point. Apply wax to inserted plate, die, charging chamber and plunger.

3. Deposit 47 grams* of particle and resin mixture into die and charging chamber. To insure that coaster product has sufficient material for the sides, hollow out the center of the charge to about ½ to ¾ inch depth. (Phenolic plastic granules can be used in place of wood particles and resin mixtures to demonstrate thermosetting plastics compression molding of products.) Experimentation as to weight of charge, time, heat and pressure will be necessary for a satisfactory product.

4. Slide die and charging chamber back into position and apply 20,000 psi pressure, if Urac resins have been used, for 2 minutes. (Requires about 1 minute to stabilize pressure.)

   NOTE: IF CYMEL OR MELURAC RESINS ARE USED IN THE MIXTURES, APPLY 25,000 PSI FOR 8 TO 10 MINUTES. NO BREATHING OR VENTING CYCLE IS REQUIRED.

5. Allow a 5 second venting cycle if necessary. (Only mixtures with Urac as a resin require this venting cycle.)

6. Apply 22,500 psi pressure for 1 minute if a venting cycle was included in the sequence operations.

7. Release pressure to allow die and charging chamber to be drawn clear of plunger. Remove product by using a blast of air from an air hose. Apply coating of wax for next cycle.

8. When process has been completed, clean die, charging chamber and plunger with steel wool and wax; replace in position with zero pressure on gauge. Turn off switches and pull power lead. Replace thermometers and clean up the area.

*Charge will vary as to particle, species and mixture.

II. PLYWOOD AND/OR LAMINATED BLANKS

1. Release hold down bolts on coaster plates and/or test dies and plungers. Remove die, plunger and/or charging chamber from top and bottom heat platens; store in locker area.

2. Secure top and bottom flat pressure platens (not shown in drawings, see Figure III-2) in position between heat platens with hold down plates. (Stainless steel plates between platens should be waxed to prevent adhesive from sticking to surface.)

3. Repeat #1 in Section 1 above, preheat platens to 200°F.

4. Repeat #2 in Section 1 above, clearance should be approximately 1 inch.

Trio Press Components, Aluminum Test Die and Plunger [left] and Plywood or blank Platens [center] [Fig. III-2]

5. Place prepared veneers or laminates between stainless steel plates. (Veneers, 1/28 inch thick, should only be single spread with plastic resin adhesive to prevent excessive squeeze out and a minimum of moisture added to veneers; this precaution will prevent warpage in the finished blank.)

6. Slide loaded platens back into position and apply 15,000 psi pressure for 1 minute when using ¼ inch thick blanks - more time should be allowed for thicker blanks.

7. Release pressure and remove blank. Clean and apply coating of wax to stainless steel plates if needed.

8. Repeat #8 in Section 1 above.

III. LAMINATION OF THERMOPLASTIC SHEETS AND/OR PRE-CUT SCRAP PIECES INTO DISCS

Procedure:

1. Release hold down bolts on coaster plates, plunger and/or pressure platens; store in locker area.

2. Secure round test disc die and plunger in position between heat platens.

3. Repeat #1 in Section 1 above. Preheat die and plunger to 380° F. (Allow 1½ to 2 hours to gain heat selected.)

4. Repeat #2 in Section 1 above. However, use aerosol special Slide Mold Release.

5. Deposit prepared sheet plastic discs into the die chamber. (Solid objects: coins, wire, etc., can be placed between sheets for permanent bonding.) If desired, scrap pieces or granulated plastic, 130 gram wt. charge, can be placed in the die chamber to be bonded into a solid disc. (Plastic sheets should be preheated in an oven at 280°F., until they

become pliable before being deposited into the die chamber. This preheating insures perfect bonding.)

6. Slide die back into position and apply 25,000 psi for 20 to 30 minutes. You may have to stabilize pressure during this time.

7. Turn off switches and pull power lead. Clean up the area. *Do not release pressure on press,* allow die and plunger to cool until they reach room temperature. (External air applied to the die and plunger will aid in the cooling process. A recirculating water jacket could be designed to decrease the mold temperature rapidly.)

8. When the mold has cooled sufficiently, release the hydraulic jack pressure. The mold may have to be removed from the heat platens to separate die, formed disc and plunger.

9. After removing formed disc, clean and wax die and plunger for next application.

10. Formed disc can be sawed, sanded and buffed to the desired shape and luster.

The following articles, bulletins and references have been selected to give you a variety of techniques, processes and information.

Gimbel, Armin F. "Your Students Can Build This Materials Testing Machine." *School Shop*, November, 1973, pp. 45-47.

Heine, Richard W. and Carl R. Loper, Jr. *Principles of Metal Casting*. New York: McGraw-Hill, 1967.

Kruyrpa, Russell. "Wood Flour Molding for Industrial Arts Laboratories. *Industrial Arts and Vocational Education*, November, 1966. p 59.

Lehmann, W.F. "Molding Compounds from Douglas-Fir Bark." *Forest Products Journal*, Vol. 18, #12, p 47.

Mater, Jean. "Bark; Problem or Opportunity?' *Woodworking Digest*, March 1969, p 24.

Molding Methods and Materials. American Foundryman's society, 1962, pp 43-54.

Oberg, Erick, and F.D. Jones. *Machiner's Handbook*. New York: Industrial Press, 1969.

"Project Sheets #1-6." Dake Corporation, Grand Haven, Michigan.

Rusinoff, S.E. *Foundry Practices*. Chicago, Ill.: American Technical Society, 1955.

Scott, Millett and Hajny. "Wood Wastes for Animal Feeding." *Forest Products Journal*, Vol. 19, #4, p 14.

Selridge, Lewis R. Jr. "Molding Wood Particles: A Small-Scale Process." *The Journal of Industrial Arts Education*, May-June, 1964, p 30.

Snyder, Charles R. "Wood Flour Molding." *School Shop*, September, 1969, p 60

White, Mark. "Distilling Wood By-Products." *Industrial Education*, October, 1973, pp. 30-31.

Trio Press supplies can be obtained from the following companies:

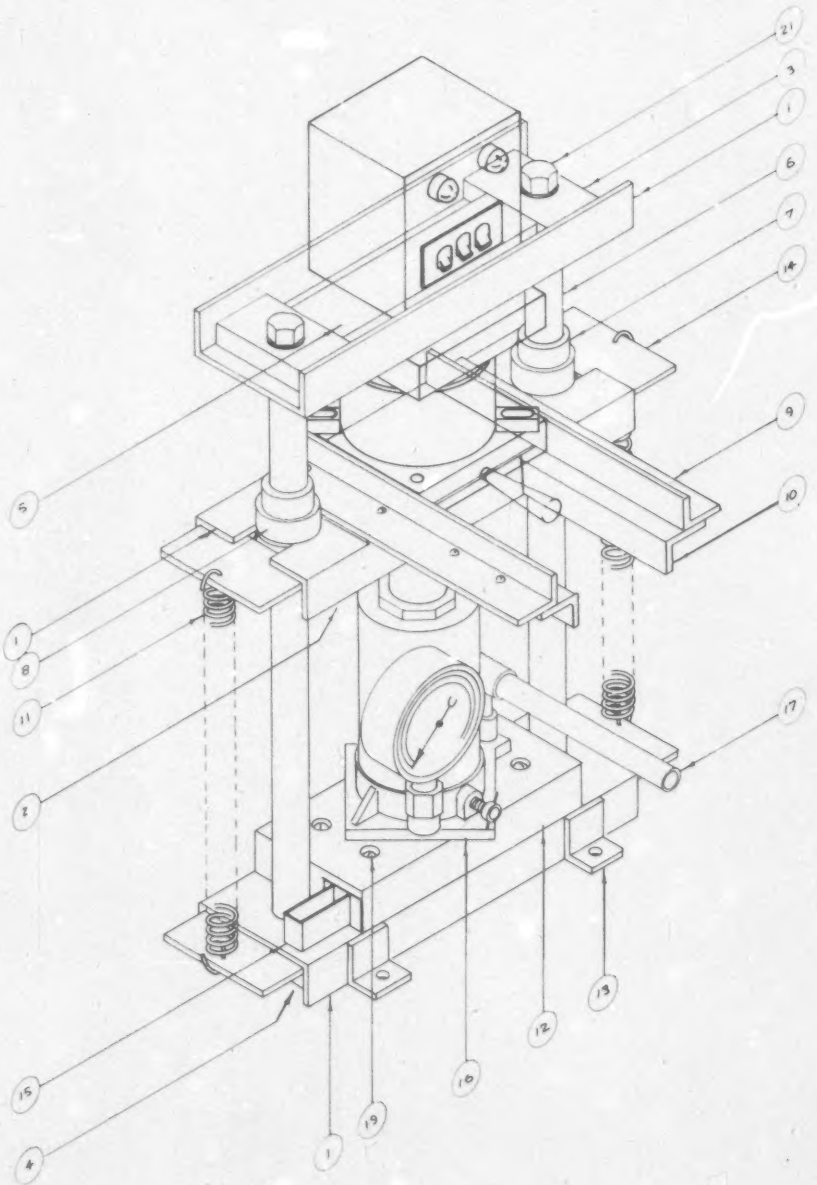
Dye Pigments. Reichard Coulston Inc., 15 East 26th St., New York, N.Y. 10010; American Cyanamid Co., Pigments Div., Wayne, N.J.; Hercules Incorporated, Imperial Color and Chemical Dept., Glenfalls, New York.

Heat Elements, Type C cartridge type, Catalog #C-143; and Thermoswitches, Cartridge type, Catalog #17002. Chromalox Catalog #67, C.B. Falls Co., Suite 1003, 317 11th St., St. Louis, Missouri 63101.

Mold Release, Special Slide, Aersol can 18 oz. Iasco Industrial Arts Supply Co., 5724 West 36th St., Minneapolis, Minnesota 55416.

Resins, Adhesive, Cymel #500 7C3-102, Melurac #304 L-7A9-033, Urac #110 L-709-003. American Cyanamid Co., Wallingford, Connecticut 06492.

Wax, Partall Paste #2. Cope Plastics Illinois Inc., 1111 West Delmar Ave., Godfrey, Ill. 62035.



					TOTAL	129.42
24	SCREW, SET	MACHINE	#10-24NC × .50	16	.02	.32
23	WASHER, LOCK	HEAVY	.75 I.D.	4	.10	.40
22	WASHER, LOCK	MEDIUM	.25 I.D.	14	.03	.42
21	BOLT		.75-16NC × 3.0	4	.36	1.44
20	SCREW	MACHINE	.25-20NC × .50	10	.03	.30
19	SCREW	MACHINE	.25-20NC × 1.50	4	.09	.36
18	GAGE, HYDRAULIC	50,000 PSI "EASTOOL	BLACKHAWK	1	42.41	42.41
17	JACK HANDLE	STEEL, PIPE	JACK ACCESSORY	1	—	—
16	JACK, HYDRAULIC	TWENTY TON CAP	BLACKHAWK EA11	1	48.64	48.64
15	STOPWATCH HOLDER	PLASTIC, SHEET	.125 × 1.625 × 10.0	1	34.58 IN.	.25
14	SPRING SUPPORT	STEEL, BAR	.25 × 3.0 × 5.25	4	.70/FT	1.23
13	FEET, SUPPORT	ANGLE IRON .25	1.5 × 2.0 × 2.0	4	44/FT	15
12	BASE, JACK	MAPLE	2.0 × 6.0 × 12.0	1	.74.80/FT	1.48
11	SPRING	STEEL	1.0 COIL × 8.0	2	.44 EA	.88
10	SLIDE	ANGLE IRON .25	1.5 × 2.0 × 8.0	2	.62/FT	.83
9	SLIDE	ANGLE IRON .25	1.5 × 2.0 × 14.0	2	.62/FT	1.45
8	COLLAR	STEEL, ROD	2.5 DIA. × 1.0	4	2.50/FT	.83
7	SLEEVES	STEEL, PIPE	2.0 DIA. × 4.0	2	.53/FT	.34
6	GUIDE	STEEL, ROD	1.5 DIA. × 26.0	2	1.55/FT	6.71
5	BRACE	STEEL, BAR	1.0 × 2.75 × 11	1	2.00/FT	1.84
4	BRACE	STEEL, BAR	1.0 × 1.0 × 11.0	2	.75/FT	1.22
3	BRACE	STEEL, BAR	1.0 × 2.75 × 5.25	4	2.00/FT	3.50
2	PRESSURE PLATE	STEEL, BAR	1.125 × 4.0 × 10	1	4.48/FT	2.80
1	TOP, BASE & PLATFORM	CHANNEL IRON .25	2.0 × 6.0 × 18.0	3	2.36/FT	10.62
NO.	NAME	MATERIAL	SIZE	REQD	UNIT COST	TOT COST

PRELIMINARY INVESTIGATIONS AND DRAWINGS BY STUDENTS, BILL FITE, RICHARD PEMBERTON AND DALE PELTON.

TRIO PRESS

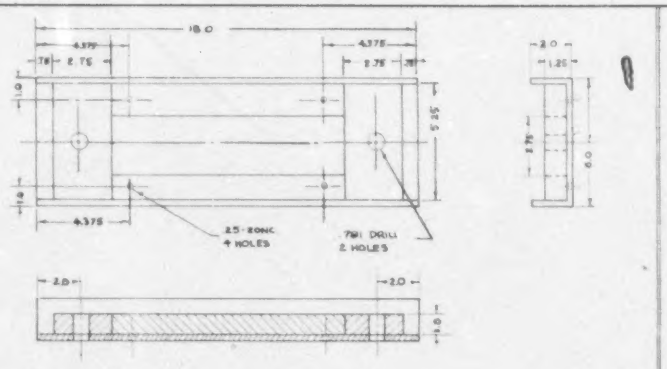
PARTICLE, PLY, AND PLASTIC

SCALE .250" = 1.0"				
DATE 7-28-70				
DRN. JCD	CHK. QCO			
APP'D BATMAN				

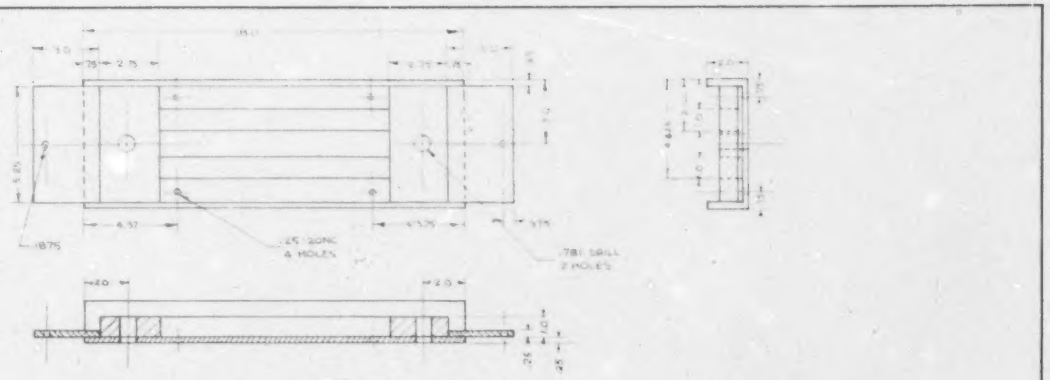
TITLE SOUTHWEST MISSOURI STATE SPRINGFIELD, MO

NO. 1 OF 4

3-10



DETAIL 1 PART NO 1,2,3,15 TOP SUPPORT SCALE: .25"=1.0"



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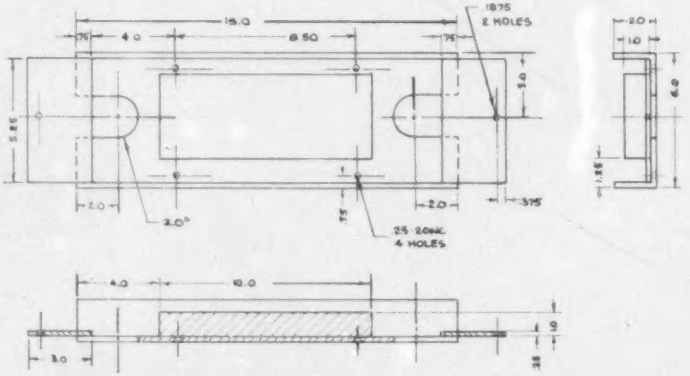

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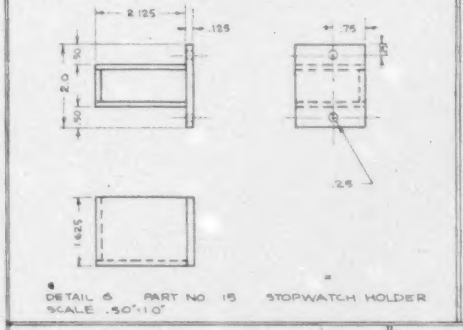

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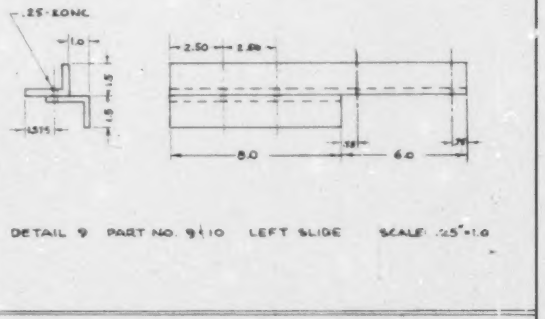

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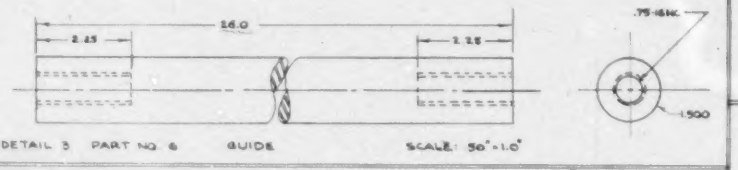

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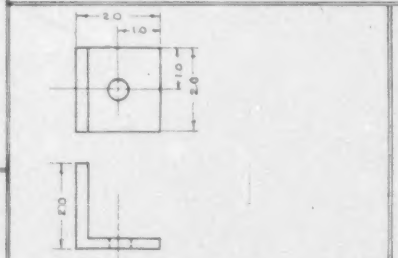

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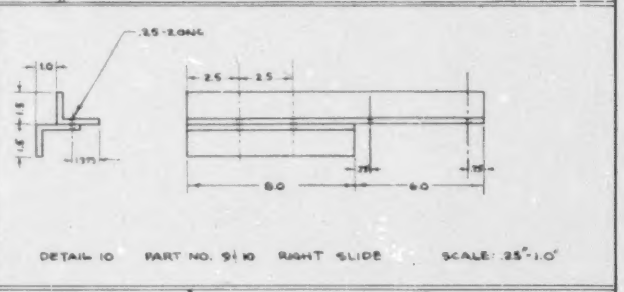

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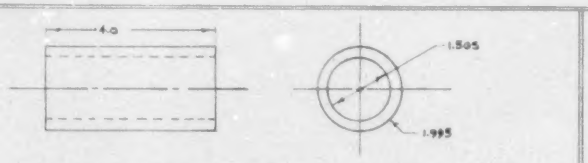

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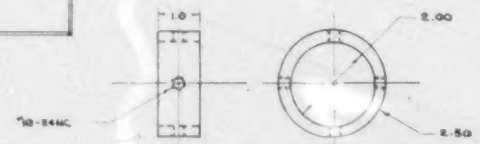


DETAIL 8 PART NO. 8 COLLAR SCALE: .50"=1.0"

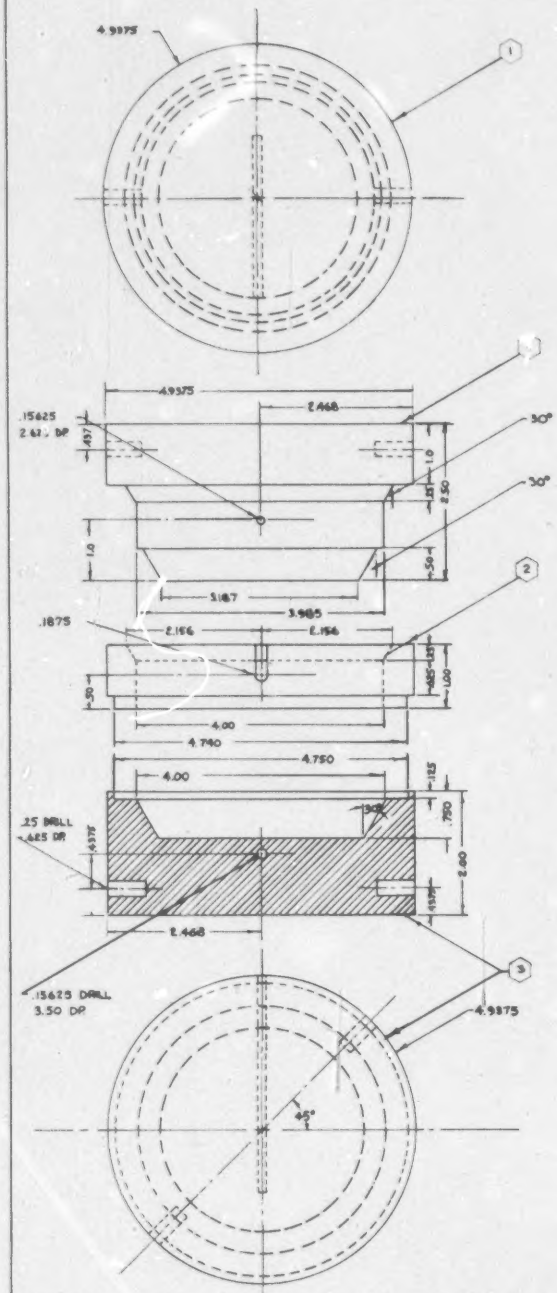
TRIO PRESS

PARTICLE, PLY, AND PLASTIC

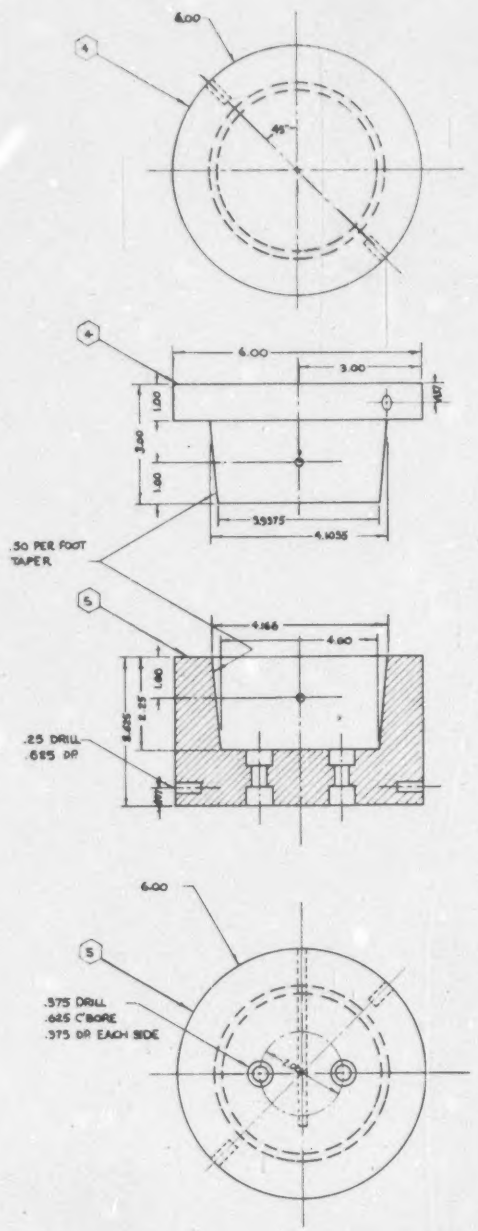
SCALE	AS SHOWN
DATE	7-28-70
DRN	JCD
CHD	OCO
APVD	O. OATMAN
TITLE	COMPONENTS
BY	
DATE	

SOUTHWEST MISSOURI STATE
SPRINGFIELD, MO

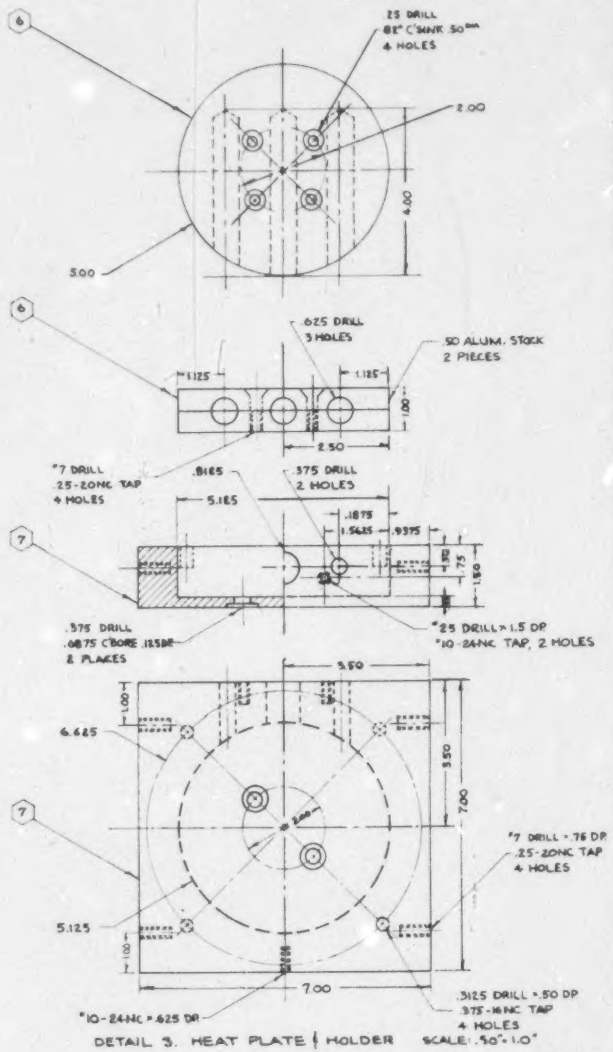
SHT 2 OF 4



DETAIL 1. WOOD FLOUR COASTER DIE SCALE: .75"=1.0"



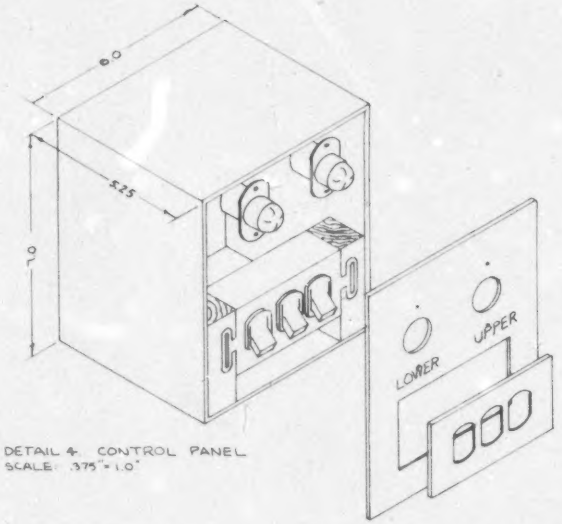
DETAIL 2. ALUMINUM TEST DIE SCALE: .50"=1.0"



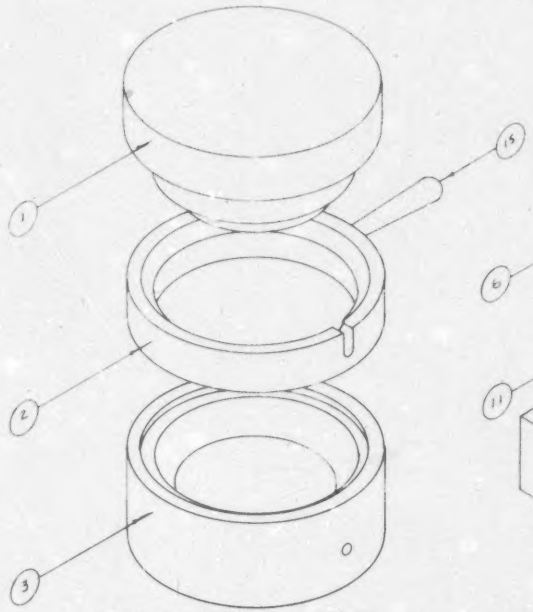
DETAIL 3. HEAT PLATE & HOLDER SCALE: .50"=1.0"

TRIO PRESS				
PARTICLE, PLY, AND PLASTIC				
SCALE AS SHOWN	COMPONENTS			
DATE 7-29-70				
DRN. JCD	CHD.			
APP'D O. OATMAN				
SOUTHWEST MISSOURI STATE SPRINGFIELD, MO.		3	OF	4

3-12



DETAIL 4 CONTROL PANEL
SCALE: .375" = 1.0"



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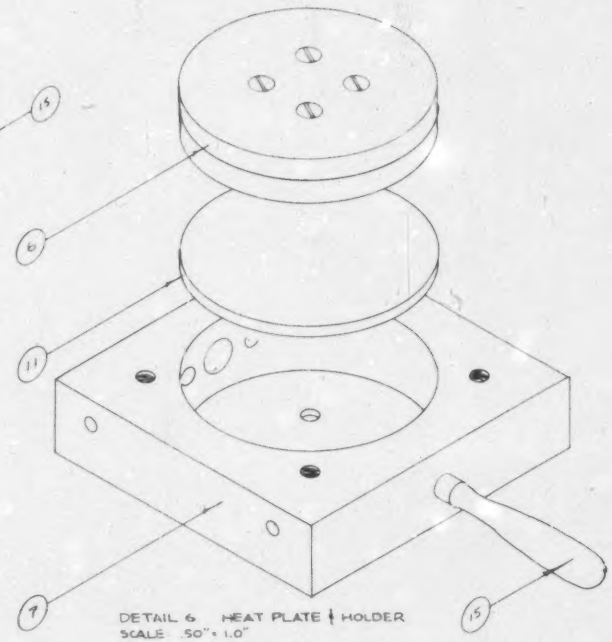
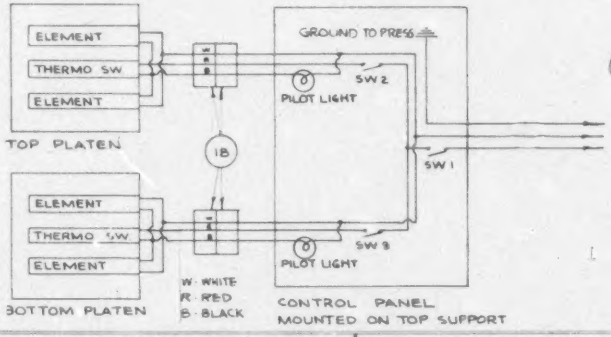
SCALE: .50" = 1.0"

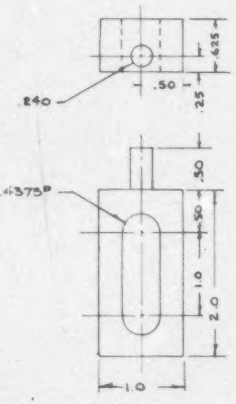


DETAIL 6 HEAT PLATE & HOLDER
SCALE: .50" = 1.0"

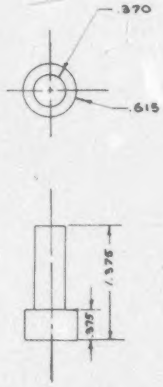


					TOTAL	14.56
18	CONNECTORS			2 PR	1.92	3.84
17	PILOT LIGHT	120 VAC RED W/ LENZ	COVER	2	.69	1.38
16	SWITCH	120 VAC SPST		3	4.50	4.50
15	HANDLE	WOOD (COPE SAW)	#10-24 NC × .50	2	.30	.60
14	THERMOMETER	50-500°F STAINLESS	8", FACE 1.75	2	7.95	15.90
13	ELEMENT	TYPE "C", 120 VAC, 165 W	.625 DIA × 2.375	4	4.35	17.40
12	THERMO SWITCH	100-600°F, 120 VAC 10A	.625 DIA × 3.71875	2	4.78	29.56
11	SHIELD	ASBESTOS	5.125 DIA × .25"	1	.20	.20
10	SUPPORT	ANGLE IRON .25	2.0 × 1.75 × 2.0	2	78/FT	.26
9	KNOCK-OUT PIN	STEEL, ROD	.625 DIA × 1.375	2	36/FT	.12
8	HOLD DOWN	STEEL	2.5 × .625 × 1.0	4	.50	2.00
7	PLATEN HOLDER	STEEL	1.5 × 7.0 × 7.0	2	6.40	12.80
6	PLATEN	ALUMINUM	#21 5.0 DIA × .50	2	2.40	4.80
5	TEST DIE	STEEL	6.00 DIA × 3.625	1	15.20	15.20
4	TEST DIE PLUNGER	STEEL	6.00 DIA × 3.0	1	13.05	13.05
3	WOOD FLOUR DIE	STEEL	4.9375 DIA × 2.0	1	8.75	8.75
2	CHAMBER (WFM)	STEEL	4.9375 DIA × 1.0	1	4.35	4.35
1	PLUNGER (WFM)	STEEL	4.9375 DIA × 2.50	1	10.85	10.85
NO.	NAME	MATERIAL	SIZE	REQD	UNIT COST	T COST

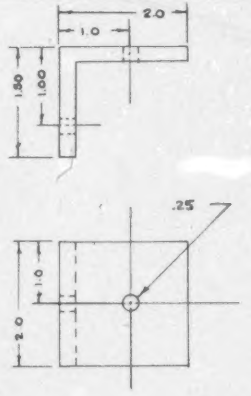
WOOD FLOUR MOLD (WFM)



DETAIL 4 PART NO. 8 HOLD DOWN
SCALE: 1.0" = 1.0"



DETAIL 5 PART NO. 9
SCALE: 1.0" = 1.0"



DETAIL 6 PART NO. 10 SUPPORT
SCALE: .75" = 1.0"

TRIO PRESS
PARTICLE, PLY AND PLASTIC

SCALE: AS SHOWN	COMPONENTS	BY	DATE
DATE: 7-30-70			
DRAWN: JCD	APP'D: DCO		
APP'D: S. OATMAN			
TITLE: SOUTHWEST MISSOURI STATE SPRINGFIELD, MO		NO. 4 OF 4	

IV. THE PRODUCTION PRODUCT OF INDUSTRY
Mass Production: Principles, Applications and Operations

Recently a large wood products industry, Francer Furniture Co., located in Salamanca, N.Y., launched a plant expansion program in which it built and outfitted two separate facilities simultaneously. The first facility, an 80,000 sq. ft. building, held the basic rough mill operations, veneer lay-ups, plastic laminations section and a variety of machines to process solid wood stock components. The second facility was an expansion of the firm's basic plant, increasing the total size of this building to 150,000 sq. ft. This building contained a complete finish mill, assembly and finishing departments.

The two new plants required the installation or relocation of more than 100 pieces of major woodworking machines. The actual completion time from groundbreaking for the two facilities to operation of the machines was 8 months. The rough mill system was in the planning stage 18 months as changes were made to keep up with new developments in equipment and technology. The consulting engineer indicated the one reason why many wood product manufacturers had to shift to highly mechanized facilities and making of large capital investment in automatic machinery was the difficulty in finding or training skilled workers.

A forward-looking attitude and a quest for the latest technology to produce finely crafted wood products is a key to success in this highly competitive industry. This particular company realized the necessity of expansion and technological improvement of its facilities. This firms expects a total capacity output to be in the vicinity of $20,000,000.00 annually. New machinery technology and new materials and methods engineering will continue to develop techniques for increasing production per unit of time for the purpose of reducing the unit cost to make business profitable.

Mass production as a basic principle of industry must be more widely taught as a unit of study and activity in our Level II industrial arts woodworking classes. It is possible to have success through a simplified approach to mass production by exploring its advantages and limitations as it applies to our industrial society. Selected references listed will give a quick summary and a variety of approaches to this important phase of industry. These published articles go much further into detail than should be attempted in this introduction to mass production.

The following considerations should be kept in mind to assure success in a mass production endeavor: select and keep operations simple so they will fit the abilities of the students involved. Plan a production line with available equipment. If the designed product requires more time than a class period for completion, set up the line so that one or more components can be completed, store the finished components and continue production at a later date. The product produced should be worthwhile and retain student pride. Fixtures and jigs should be inexpensive, easily constructed and consume a minimum amount of time in fabrication. This will allow changes in various production products or model changes with a minimum expense involved.

In a manufacturing industry the production group determines if a product is going to be produced on a competitive basis. After they have received working drawings from the product engineering section they are responsible for designing, creating and selecting the best manufacturing methods, processes, tools, equipment, time and skills needed to manufacture a product.

Methods engineering must develop techniques for increasing the production per unit of time for the purpose of reducing the unit cost. To accomplish this, surveys are made, facts are gathered, analyses are made, and in general, all the information concerning the methods for producing a product is compiled in an orderly and systematic manner.

John Dryton, a senior Industrial Technology student enrolled in a Motion and Time Study class at Southwest Missouri State University, assuming the role of a methods engineer, accepted the

assignment of analyzing the product, interior wood shutters, for this unit of the woods curriculum guide. After the product had been selected, designed and the drawings completed (Drawing 101) it was necessary to work out the sequence of events in a chronological order from the raw material to the assembly of the finished product. To satisfy this need, an Operation Process Chart (Drawing 101-A) was constructed as a graphic representation of the points at which materials were introduced into the process, sequence of inspections and all operations involved.

After all operations were recorded the next procedure was determining the actual flow through the laboratory area. Using existing equipment in their locations in the Industrial Education Laboratory at Southwest Missouri State University, a Flow Process Chart and Flow Diagrams (Drawing 101-B part numbers 101-1, 101-2, 101-3, 4, 101-5) were constructed. These steps gave a realistic view of transportation, delays and storage of shutter components. To aid production workers, Component Process Route Sheets were assembled to facilitate production requests. A Methods Outline or "Steps of Procedure" was also assembled for planning convenience.

In summary, the production of the interior window shutters involved: 50 operations, 16 inspections, 41 transportations for a total of 1,126 feet, 8 storages and 22 delays.

The product, interior window shutters, has been analyzed to aid you in setting up your own mass production unit or duplicating this product as a "starter". The shutter production has been tested in a typical industrial arts "shop" or laboratory and has provided an incentive and challenge for the students involved. The bulk of the material used can be received free from small industries using ponderosa or white pine as raw materials for mill products.

FLOW PROCESS CHART

SUBJECT CHARTED Louvers for Interior Window Shutters CHART NO 101-1-A

DRAWING NO 101 PART NO 101-1 CHART OF METHOD

CHART BEGINS In stock room CHARTED BY John Dryton

CHART ENDS At assembly area DATE 5/25/70 SHEET 1 OF 2

DIST IN FEET	UNIT TIME MIN	CHART SYMBOLS	PROCESS DESCRIPTION	DIST IN FEET	UNIT TIME MIN.	CHART SYMBOLS	PROCESS DESCRIPTION
		1	In stock room			1	Inspect 10% spot check
		A	Material loaded onto a 4 wheeled cart	27		5	To surfacer #3
25		1	To surfacer #3			5	Surface 5° taper
		1	Surface stock to thickness			2	Inspect 100%
		1	Wait for move - man	54		6	To shaper #4
19		2	To jointer #2A & 2B			6	Shape radius on edges
		2	Joint edge			4	Wait for move-man
		2	Wait for move - man	58		7	To radial arm saw #5A
13		3	To table saw #1			7	Square end, cut to length
		3	Rip to thickness	33		8	To radial arm saw #5B
		3	Wait for move - man			8	Saw tenon shoulders one side
10		4	To jointer #2A & 2B			5	Wait set-up man
		4	Joint sawed edges			9	Saw tenon shoulders remaining side

FLOW PROCESS CHART

SUBJECT CHARTED Louvers for Interior Window Shutters CHART NO 101-1-A

DRAWING NO 101 PART NO 101-1 CHART OF METHOD

CHART BEGINS In stock room CHARTED BY John Dryton

CHART ENDS At assembly area DATE 5/25/70 SHEET 2 OF 2

DIST IN FEET	UNIT TIME MIN	CHART SYMBOLS	PROCESS DESCRIPTION	DIST IN FEET	UNIT TIME MIN	CHART SYMBOLS	PROCESS DESCRIPTION
		3	Inspect 10% spot check				
58		9	To band saw #6A				
		10	Rip stubby tenon cheek				
		6	Wait for move - man				
35		10	To lathe #7				
		11	Round tenon				
		4	Inspect 10% spot check				
23		11	To drill press #8A				
		12	Drill pilot holes for staple				
		5	Check over-all dimensions				
6		12	To assembly area				
		2	Stored until assembly				

FLOW PROCESS CHART

SUBJECT CHARTED Stiles for Interior Window Shutters — CHART NO 101-2-A

DRAWING NO 101 — PART NO 101-2 — CHART OF METHCD

CHART BEGINS In stock room — CHARTED BY John Dryton

CHART ENDS At assembly area — DATE 5/25/70 SHEET 1 OF 1

DIST IN TIME	UNIT TIME MIN.	CHART SYMBOLS	PROCESS DESCRIPTION	DIST IN TIME	UNIT TIME MIN.	CHART SYMBOLS	PROCESS DESCRIPTION
		3	In stock room	11		18	To table saw #1
		B	Material loaded onto a 4 wheeled cart			18	Plow open end
25		13	To surfacer #3			10	Wait for move-man
		13	Surface stock to thickness	29		19	To mortiser #9
		7	Wait for move-man			19	Square shoulder cuts
19		14	To jointer #2A & 2B			7	Inspect 10% spot check
		14	Joint one edge	48		20	To shaper #4
		8	Wait for move-man			20	Shape cove on inside edges
13		15	To table saw #1			8	Check dimensions
		15	Rip to parallel width	59		21	To drill press #8 B
		9	Wait for move-man			21	Drill tenon holes
10		16	To jointer #2A & 2B			9	Check over-all dimensions
		16	Joint to finished width			4	Stored until assembly
		6	Check dimensions				
8		17	To radial arm saw #5A				
		17	Square end, cut to length				

FLOW PROCESS CHART

SUBJECT CHARTED Rails for Interior Window Shutters CHART NO 101-3, 4-A

DRAWING NO 101 PART NO 101-3; 101-4 CHART OF METHOD

CHART BEGINS In stock room CHARTED BY John Dryton

CHART ENDS At assembly area DATE 5/25/70 SHEET 1 OF 2

DIST IN FEET	UNIT TIME MIN.	CHART SYMBOLS	PROCESS DESCRIPTION	DIST IN FEET	UNIT TIME MIN.	CHART SYMBOLS	PROCESS DESCRIPTION
		5	In stock room			25	Joint to finished width
		C	Material loaded onto a 4 wheel cart			10	Check dimensions
25		22	To surfacer #3	62		26	To shaper #4
		22	Surface stock to thickness			26	Shape cove on inside edges
		11	Wait for move-man			14	Wait for move-man
19		23	To jointer #2A & 2B	58		27	To radial arm saw #5A
		23	Joint one edge			27	Square end, cut to length
		12	Wait for move - man			15	Wait for move-man
13		24	To table saw #1	33		28	To radial arm saw #5B
		24	Rip to width			28	Cross cut tenon shoulders each end & edges
		13	Wait for move-man			16	Wait for set-up man
10		25	To jointer #2A & 2B			29	Cut tenons to finished dimensions, cheek cuts

FLOW PROCESS CHART

SUBJECT CHARTED Rails for Interior Window Shutters CHART NO 101-3, 4-A

DRAWING NO 101 PART NO 101-3; 101-4 CHART OF METHOD

CHART BEGINS In stock room CHARTED BY John Dryton

CHART ENDS At assembly area DATE 5/25/70 SHEET 2 OF 2

DIST IN FEET	UNIT TIME MIN	CHART SYMBOLS	PROCESS DESCRIPTION	DIST IN FEET	UNIT TIME MIN.	CHART SYMBOLS	PROCESS DESCRIPTION
		17	Wait for move-man				
25		29	To work bench				
		30	Lay-out tenon angles				
27		30	To band saw #6A				
		31	Cut tenon angles				
		11	Inspect 10% spot check				
41		31	To drill press #8A				
		32	Drill recess for adjustment rod				
		12	Check over-all dimensions				
6		32	To assembly area				
		6	Stored until assembly				

FLOW PROCESS CHART

SUBJECT CHARTED Adjustment Rod For interior Window Shutters — CHART NO 101-5-A

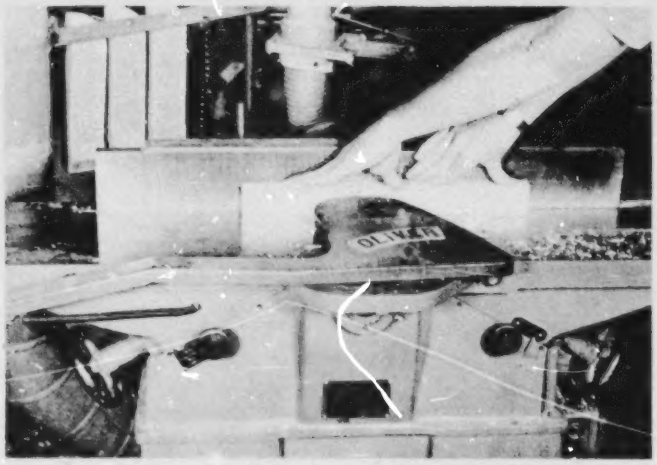
DRAWING NO 101 — PART NO 101-5 — CHART OF METHOD

CHART BEGINS In stock room — CHARTED BY John Dryton

CHART ENDS At assembly area — DATE 5/25/70 SHEET 1 OF 1

DIST IN FEET	UNIT TIME MIN.	CHART SYMBOLS	PROCESS DESCRIPTION	DIST IN FEET	UNIT TIME MIN.	CHART SYMBOLS	PROCESS DESCRIPTION
		▽ 7	In stock room			▽ 21	Wait for move-man
		(D)	Material loaded onto a 4 wheel cart	18		⇨ 38	To work bench
25		⇨ 33	To surfacer #3			(38)	Lay-out staple locations
		(33)	Surface stock to thickness	16		⇨ 39	To drill press #8A
		▽ 18	Wait for move-man			(39)	Drill pilot holes
19		⇨ 34	To jointer #2A & 2B			▽ 22	Wait for move-man
		(34)	Joint one edge	59		⇨ 40	To shaper #4
		▽ 19	Wait for move-man			(40)	Shape radius on corners
13		⇨ 35	To table saw #1			[14]	Check over-all dimensions
		(35)	Rip to rough width	50		⇨ 41	To assembly area
		▽ 20	Wait for move-man			▽ 8	Stored until assembly
10		⇨ 36	To surfacer #3				
		(36)	Surface to finished width				
		[13]	Check dimensions				
8		⇨ 37	To radial arm saw #5A				
		(37)	Square end, cut to length				

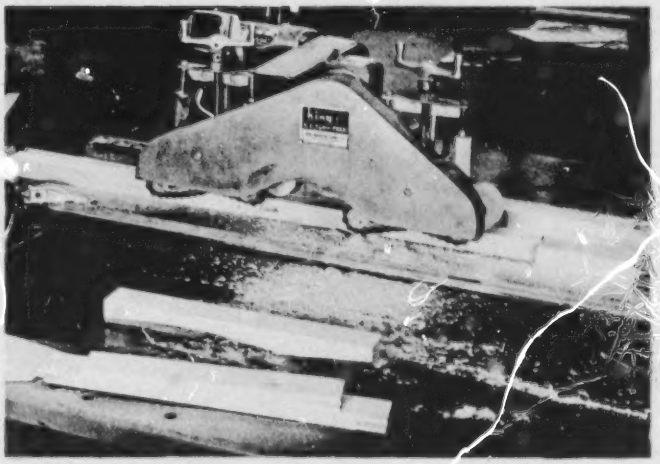
INTERIOR WINDOW SHUTTER METHODS STUDY



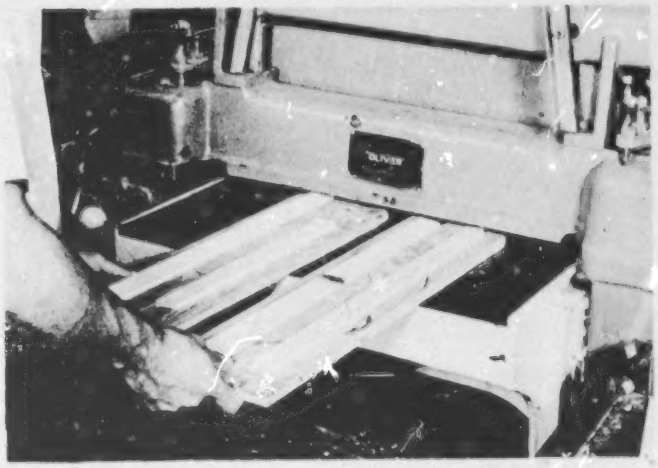
Jointing Operation on Jointer 2B [Fig. IV-1]

I. *Louvers*

1. Surface stock to 1-¼" thickness, material can be random width and length (RW&L).
2. Joint edges. (Fig. IV-1)
3. Rip 5/16" thickness stock from the edges. (Fig. IV-2)
4. Joint sawed edges of RW & L stock.
5. Repeat steps 3 and 4 until stock is depleted.
6. Place ripped 5/16" thick stock on prepared "carrier", sawed surface up, and surface to tapered dimensions. (Carrier should be prepared from 3/4" Douglas Fir plywood 6" wide and of varied length, having 2 sawed grooves 5 degrees off perpendicular to support the jointed surface.) (Fig. IV-3)
7. Shape desired or specified radius on edges of random length stock. (Set up shaper with featherboard and stock hold-downs for safety and to aid in continuous feeding of tapered stock.) (Fig. IV-4)
8. Square one end of tapered, shaped stock. Place squared end against stop block and square off 2nd end to finished louver length, allowing sufficient stock for tenons on each end. (Set up stop block and use hollow-ground veneer blade for best results). (Fig. IV-5)



Ripping Operation on Table Saw, Using Automatic Feed [Fig. IV-2]

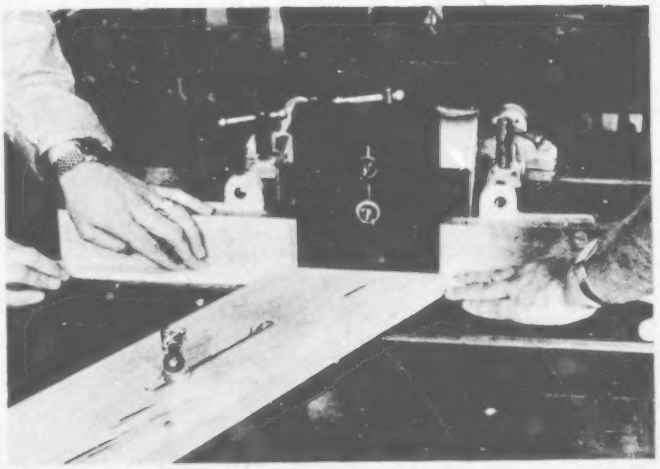


Taper Surfacing Operation, Using Prepared 'Carrier' [Fig. IV-3]

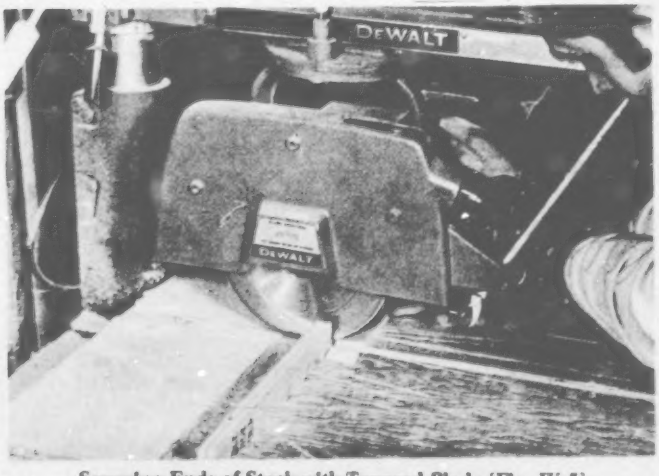
9. Saw tenon shoulder cuts on each end of louver stock, re-adjust height of saw blade and cut tenon shoulder cuts on each end of 2nd edge. (Set up stop block and carefully check tenon material left on sample cuts before continuing with balance of louver stock. A hollow-ground veneer blade is desirable).
10. Rip stubby tenon cheek cuts on band saw. (Set up stop block on fence and allow waste stock to fall away from blade and fence.) (Fig. IV-6)
11. Force stubby tenon stock into a revolving hollow die to produce a

round tenon of desired dimension. (Die can be made by drilling a hole of specified size into a ½" cold rolled steel plate. Secure die to a wood lathe screw chuck and revolve at high speed in the lathe. A temporary table and guides must be set up on the lathe bed to enable the stubby tenon stock to be forced horizontally into the hollow die.) (Figure IV-7)

12. Remove surplus curl of wood left on the shoulder of round tenon with a file or rasp.
13. Drill pilot holes in center of large radius edge for staple. (Fig. IV-8)
14. Use abrasive paper to remove machine marks on surface and edges. (This step optional).



Shaping Radius Edges with Hold-down and Featherboard [Fig. IV-4]

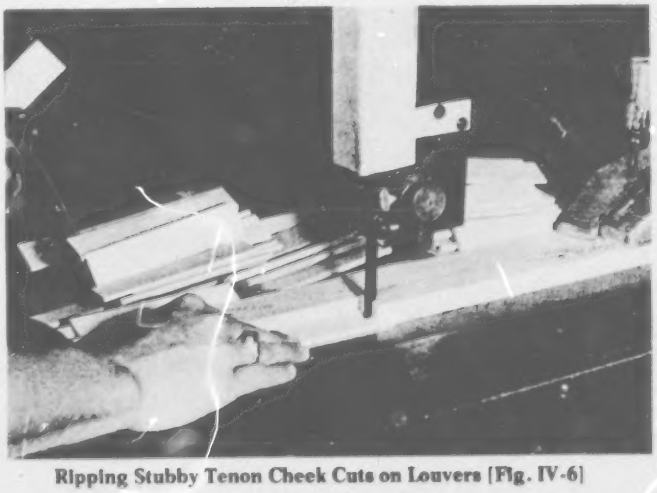


Squaring Ends of Stock with Tapered Blade [Fig. IV-5]

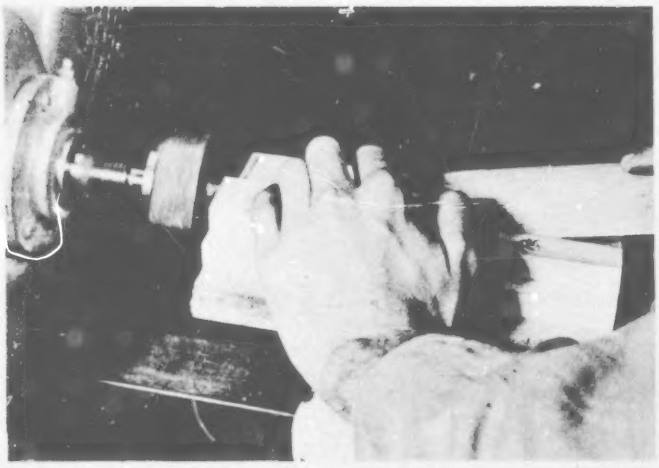
II. *Stiles*

1. Surface stock to 11/16".
2. Joint one edge.
3. Rip stock to rough width, leave stock for jointing 2nd edge to finished dimension.
4. Joint to finished width.
5. If stock was RW & L, repeat steps 2 through 4 until stock width is depleted.
6. Square one end of stock, place squared end against stop block and square off 2nd end to finished dimension.
7. Plow open end, centered mortise on each edge of stile. (Set up stop to insure that mortise does not extend further than desired.)

8. With hollow chisel mortiser or chisel, square shoulder cuts on inside edge and end of open end mortise to receive angular tenon of rails.
9. Shape enclosed cove cut on inside edges, leaving 7/16" raised edge in center. (Use extended stops on shaper fence to insure correct shaping distances).
10. On inside edge, mark and drill holes to receive round louver tenons. (Fig. IV-9)
11. Use abrasive paper to remove sharp edges left by shaping and drilling operations. (Surface abrasive work on stiles is optional).



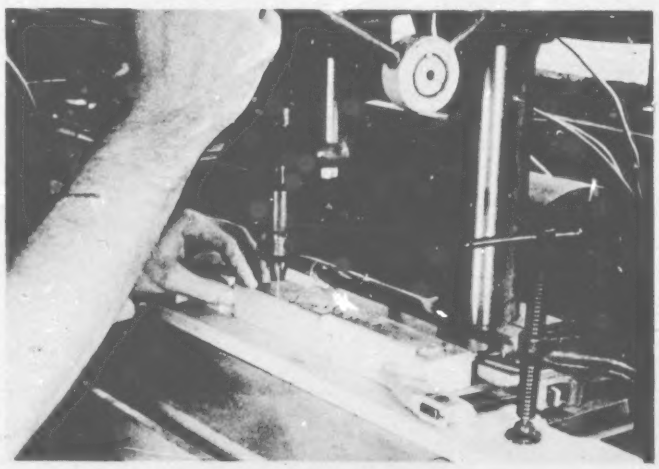
Ripping Stubby Tenon Cheek Cuts on Louvers [Fig. IV-6]



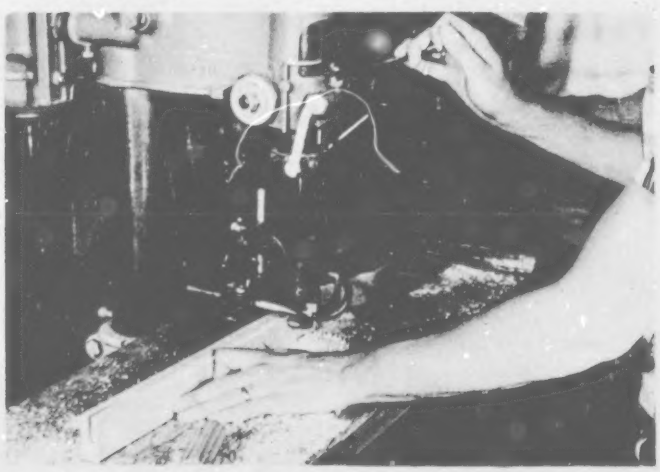
Rounding Louver Tenon, Operation #11 [Fig. IV-7]

III. *Rails*

1. Surface stock to 9/16".
2. Joint one edge.
3. Rip stock to rough widths, leave stock for jointing 2nd edge to finished dimension.
4. Joint to finished width.
5. If stock was RW & L, repeat steps 2 through 4 until stock is depleted.
6. Shape cove cut on inside edges leaving raised edge in center.
7. Square one end of stock, place squared end against stop block and square off 2nd end to finished dimension; allow extra length for tenons on each end.
8. Cross cut tenon shoulder cuts on each end and surface for centered tenon; remove surplus material on each cheek of tenon.
9. Place rail on edge and make shoulder cut on inside edge, remove surplus material on edge to complete bare-faced tenon. (Use stop block to insure all tenon shoulder cuts will be in alignment.)
10. Lay out and cut angle on tenon to fit in prepared stile slip mortise. Joints should be closed on shoulders and ends. (Fig. IV-10)
11. Drill with forstner bit recessed depth on inside edge of rails to receive louver adjustments rod in up or down position. (Fig. IV-11)
12. Use abrasive paper to remove rough surfaces left by machine operations. (This step optional).



Drilling Pilot Holes for Louver Staples [Fig. IV-8]



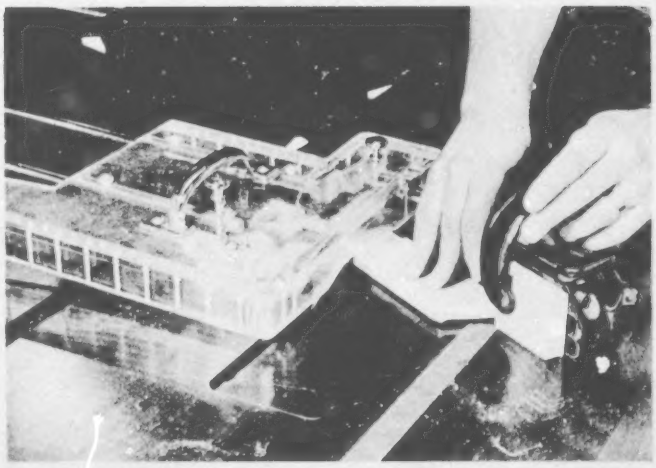
Operation #21, Drill Tenon Holes [Fig. IV-9]

IV *Louver adjustment rod*

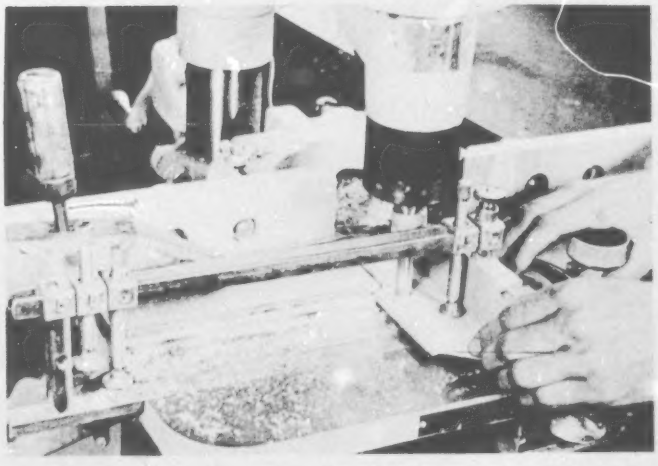
1. Surface stock to 3/8".
2. Joint one edge.
3. Rip stock to rough width, leave stock for jointing 2nd edge to finished dimension.
4. Joint one surface to finished width.
5. If stock was RW & L, repeat steps 2 through 4 until stock width is depleted.
6. Square one end of stock, place squared end against stop block and

square 2nd end to finished dimensions.

7. Lay out on rod and drill staple pilot holes along the entire length for required number of louvers. Staples to be placed on center and positioned lengthwise of rod. (Fig. IV-12)
8. Shape radius on all corners, using hold-downs and featherboard. If ends are to be rounded use rasp and/or abrasive paper.
9. Use abrasive paper to remove rough surface left by machine operations. (This step optional).



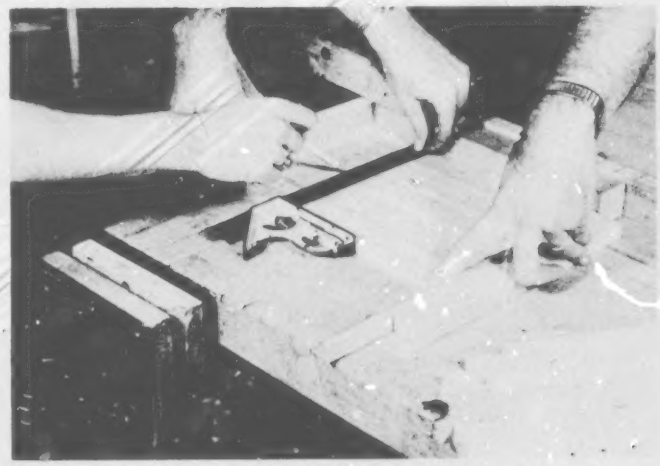
Cut Tenon Angle on Rail [Fig. IV-10]



Machining Recess for Adjustment Rod [Fig. IV-11]

V. *Trial assembly of shutter components*

1. Drive staples in pre-drilled edge of adjustment rod, use spacer to insure uniform depth.
2. Prepare a jig and fixture to hold required number of stiles, rails, and louvers. Louvers should be in an upright position, properly spaced with the largest radius up. (To prepare jig and fixture use 3/4" Douglas Fir plywood as a base; joint a 2-½ degree bevel on edge of spacer stock of the correct width and thickness to support individual louvers; secure spacers to base; secure correct thickness of stock to base to shim up and support a stile on each side of spacers; tenon holes should be level with louver tenons).
3. Position a stile on shim supports on one side of spacers.
4. Position louvers between spacers on jig with tenons inserted in stile holes.
5. Insert rails in 2nd stile, position stile and rails on shim supports on 2nd side of spacers. Slide stile and rails into mortises and louvers into tenon holes. If all dimensions have been held to a close tolerance this should be an easy operation; if not, a small sidewise movement of



Operation #33 on Adjustment Rods [Fig. IV-12]

louvers into 2nd stile may be necessary. Position or close up slip mortise and tenon joints on rails and stiles; louvers will align themselves.

6. Position adjustment rod with staples over the center of the upright louvers. Insert louver staples through rod staples and drive or push into louvers.
7. Remove assembled shutter from jig and test open and closed position of rod louvers. Note or mark corrections to be made.
8. If necessary, disassemble components, make adjustments or corrections, re-assemble for storage or prepare for adhesive.

VI. *Final assembly and fitting of hardware*

1. Apply a plastic resin, water resistant adhesive to slip mortise and tenon joints; re-assemble in jig and fixture. Use necessary number and types of clamps to square up all joints. Finishing nails can be driven into the joints from the window side and countersunk to allow clamps to be removed while adhesive is drying.
2. Extreme care should be taken at this point to remove all adhesive that is forced from the joint.
3. Allow correct drying time for adhesive.
4. Attach hardware for hanging 4 shutter panels using adjustable wraparound hanging hinges. (Hardware Kit #99391, Sears, Roebuck and Co. has proven successful--other suppliers have equal hardware kits.)
5. Follow directions on hardware package for assembly and installing.
6. Make final adjustments and corrections before finish is applied.

VII. *Finish*

1. Remove shutters from windows, identify so they may be replaced in correct sequence, remove hardware, and touch up rough areas from installation with abrasive paper.
2. Apply desired finish with proper technique to insure a quality product.

PROCESS ROUTE SHEETS

Process route sheets of each shutter component have been included for your study. The component drawings normally located on the route sheets are illustrated on Drawing 101-C.

(For component drawing see Drawing 101-C)

PROCESS ROUTE SHEET

Part 1 of 5

Patt. Name Interior Window Shutters Patt. No. 101

Part Name Louver Part. No. 101-1

No. Used Per Unit 25 Material Ponderosa Pine

	LENGTH	WIDTH	THICK		LENGTH	WIDTH	THICK
ROUGH	RANDOM	RANDON	1 1/2"	FINISH	5 5/8"	1 1/4"	9/32-5/32"

Oper. No.	Mach. No.	OPERATION AND INSTRUCTIONS	Total Passes Per Operation	Oper. Time	Set-up Time
1	3	Surface	2		
2	2	Joint	2		
3	1	Rip	1		
4	2	Joint	1 (2)		
5	3	Surface	1		
6	4	Shape edges	2		
7	5A	Cut to length	2		
8	5B	Cut tenon shoulders one side	2		
9	5B	Cut tenon shoulders 2nd side	2		
10	6A	Rip tenon cheeks	4		
11	7	Form tenon	2		
12	8A	Drill staple holes	2		

(For component drawing see Drawing 101-C)

PROCESS ROUTE SHEET

Part 2 of 5

Patt. Name Interior Window Shutters Patt. No. 101

Part Name Stile Part No. 101-2

No. Used Per Unit 2 Material Ponderosa Pine

	LENGTH	WIDTH	THICK		LENGTH	WIDTH	THICK
ROUGH	29 3/8"	1 13/16"	3/4"	FINISH	29 5/16"	1 3/4"	11/16"

Oper. No.	Mach. No.	OPERATION AND INSTRUCTIONS	Total Passes Per Oper.	Oper. Time	Set-Up Time
13	3	Surface	2		
14	2	Joint	1		
15	1	Rip	1		
16	2	Joint	1		
17	5A	Square ends	2		
18	1	Plow mortises	2		
19	9	Square mortise ends	2		
20	4	Shape coves	2		
21	8B	Drill	25		

(For component drawing see Drawing 101-C)

PROCESS ROUTE SHEET

Part 3 of 5

Patt. Name Interior Window Shutters

Patt. No. 101

Part Name Upper Rail

Part No. 101-3

No. Used Per Unit 1

Material Ponderosa Pine

	LENGTH	WIDTH	THICK		LENGTH	WIDTH	THICK
ROUGH	7 1/2"	1 13/16"	3/4"	FINISH	7 13/32"	1 3/4"	9/16"

Oper. No.	Mach. No.	OPERATION AND INSTRUCTIONS	Total Passes per Operation	Oper. Time	Set-Up Time
22	3	Surface	2		
23	2	Joint	2		
24	1	Rip	1		
25	2	Joint	1 (2)		
26	4	Shape coves	2		
27	5A	Square ends	2		
28	5B	Cut tenon shoulders	6		
29	5B	Cut tenon cheeks	4		
30		Lay out tenon angle	2		
31	6A	Cut tenon angles	2		
32	8A	Machine rod clearance	1		

(For component drawings see Drawings 101-C)

PROCESS ROUTE SHEET

Part 4 of 5

Patt. Name Interior Window Shutters

Patt. No. 101

Part Name Lower Rail

Part No. 101-4

No. Used Per Unit 1

Material Ponderosa Pine

	LENGTH	WIDTH	THICK		LENGTH	WIDTH	THICK
ROUGH	7 1/2"	2 1/2"	3/4"	FINISH	7 13/32"	2 7/16"	9/16"

Oper. No.	Mach. No.	OPERATION AND INSTRUCTIONS	Total Passes Per Oper.	Oper. Time	Set-Up Time
22	3	Surface	2		
23	2	Joint	2		
24	1	Rip	1		
25	2	Joint	1 (2)		
26	4	Shape coves	2		
27	5A	Square ends	2		
28	5B	Cut tenon shoulders	6		
29	5B	Cut tenon cheeks	4		
30		Lay out tenon angle	2		
31	6A	Cut tenon angles	2		
32	8A	Machine rod clearance	1		

(For component drawing see Drawing 101-C)

PROCESS ROUTE SHEET

Part 5 of 5

Patt. Name Interior Window Shutters

Patt. No. 101

Part Name Louver Adjustment Rod

Part No. 101-5

No. Used Per Unit 1

Material Ponderosa Pine

	LENGTH	WIDTH	THICK		LENGTH	WIDTH	THICK
ROUGH	25 1/8"	RANDOM	3/4"	FINISH	25"	3/8"	3/8"

Oper. No.	Mach. No.	OPERATION AND INSTRUCTION	Total Passes Per. Oper.	Oper. Time	Set-Up Time
33	3	Surface	2		
34	2	Joint	2		
35	1	Rip	1		
36	3	Surface	1 (2)		
37	5A	Square stock	2		
38		Lay out holes for staples	100		
39	8A	Drill	50		
40	4	Shape radius	4		

The following articles, bulletins and references have been selected to give you a variety of techniques, processes and information.

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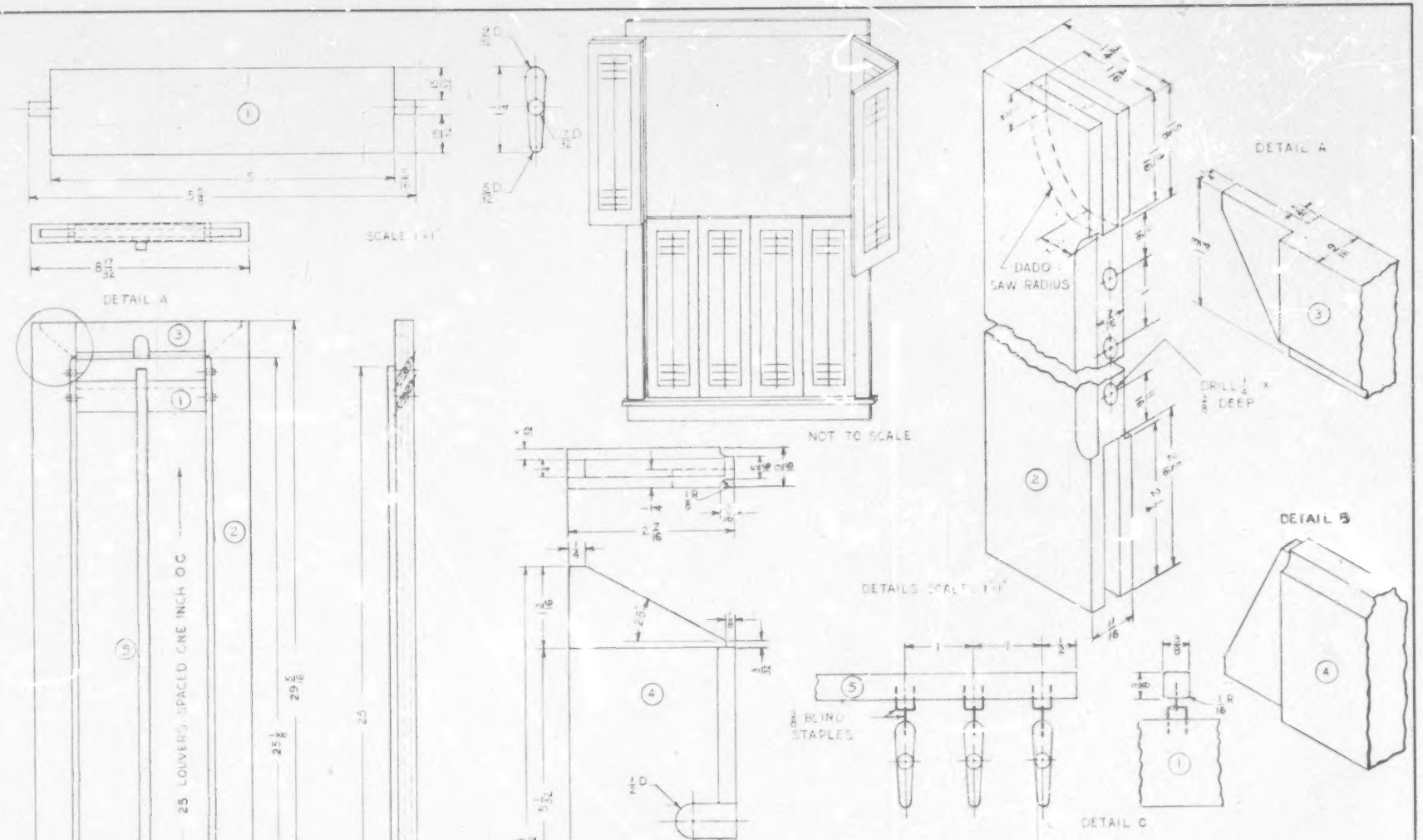


	FINISH	AS DESIRED						
	STAPLES	COPPER	50	18 GAGE #1 50 lb.				.04
5	ROD	"	1	1/2 x 1 1/8 x 25	1" x 1" x 25		.09	.04	.04
4	LOWER RAIL	"	1	1/8 x 2 1/8 x 7 1/2	1" x 2 1/8 x 7 1/2		.13	.06	.06
3	TOP RAIL	"	1	1/8 x 1 1/8 x 7 1/2	1" x 1 1/8 x 7 1/2		.10	.04	.04
2	STILES	"	2	1/8 x 1 1/8 x 29	1" x 1 1/8 x 29	.36	.72	.16	.32
1	LOUVERS	P. PINE	25	1/8 x 1 1/8 x 5	1" x 1 1/8 x 5	.03	.75	.02	.50
PART NO.	PART	MATERIAL	REQ.	CUT-OUT SIZE	FINISH SIZE	UNIT BD.FT.	TOT. BD.FT.	UNIT COST	TOT. COST

UNIT AND TOTAL COST FIGURED ON CUT-OUT SIZES WITH THE LISTED COST PER BD. FT. NO ALLOWANCE HAS BEEN MADE FOR SAW KERF WASTE. WOOD 1 1/8" D SELECT, S2S, .47 BD. FT. AND 1" D SELECT, S2S, .44 BD. FT.

REVISIONS		
NO.	DATE	BY
1		
2		
3		
4		
5		

INTERIOR WINDOW SHUTTER'S

INDUSTRIAL EDUCATION
SOUTHWEST MISSOURI STATE COLLEGE

DAN SIMPSON	AS SHOWN	PONDEROSA PINE	
JOE COBB	3-1-70		
LEON PHIPPS	O. OATMAN		101

4-20

OPERATION PROCESS CHART

SUBJECT CHARTED: INTERIOR WINDOW SHUTTER DATE 5/70
DRAWING NO. 101-A PART NO 101-1,2,3,4,5 JCD

ADJUSTMENT ROD (1 REQD), 101-5-A
25-1/8" x RANDOM x 3/4" PONDEROSA PINE
33 SURFACE STOCK TO 3/8"
34 JOINT ONE EDGE
35 RIP TO WIDTH (ROUGH) 7/16"
36 SURFACE TO FINISHED DIMENSION 3/8
13 CHECK DIMENSIONS
37 SQUARE END, CUT TO FINISHED LENGTH
38 LAYOUT FOR STAPLE LOCATION
39 DRILL PILOT HOLES FOR STAPLES
40 SHAPE RADIUS ON ALL CORNERS
14 CHECK OVER-ALL DIMENSIONS
RAILS (2 REQD), 101-34-A
7-1/2" x 1-13/16" x 3/4", 7-1/8" x 2-1/2" x 3/4"
22 SURFACE STOCK TO 9/16"
23 JOINT ONE EDGE
24 RIP TO WIDTH 1-13/16 & 2 1/2
25 JOINT TO FINISHED DIMENSION 1 3/4 & 2 7/16
10 CHECK DIMENSIONS
26 SHAPE COVE ON INSIDE EDGE
27 SQUARE END, CUT TO FINISHED LENGTH
28 CROSS CUT TENON SHOULDERS
29 CUT TENONS TO FINISHED DIMENSIONS
30 LAY OUT ANGLES FOR TENONS
31 CUT TENON ANGLE
11 INSPECT 10%
32 DRILL RECESS FOR ADJUSTMENT ROD
12 CHECK OVER ALL DIMENSIONS
STILES (2 REQD), 101-2-A
29-3/8" x 1-13/16" x 3/4" PONDEROSA PINE
13 SURFACE STOCK TO 11/16" THICKNESS
14 JOINT ONE EDGE
15 RIP TO PARALLEL WIDTH 1-13/16
16 JOINT TO FINISH DIMENSION 1-3/4"
6 CHECK DIMENSIONS
17 SQUARE END, CUT TO FINISHED LENGTH
18 PLOW OPEN-END MORTISE
19 SQUARE SHOULDER CUTS, MORTISE
7 INSPECT 10%
20 SHAPE COVE ON INSIDE EDGES
8 CHECK DIMENSIONS
21 DRILL TENON HOLES
9 CHECK OVER-ALL DIMENSIONS
LOUVERS (25 REQD), 101-1-A
RANDOM x RANDOM x 1-1/2" PONDEROSA PINE
1 SURFACE STOCK TO 1 1/4" THICKNESS
2 JOINT EDGES
3 RIP TO 5/16" THICKNESS
4 JOINT SAWED EDGES
1 INSPECT 10%
5 SURFACE, 5° TAPER
E INSPECT 100%
6 SHAPE RADIUS ON TAPERED EDGES
7 SQUARE ONE END, CUT TO FINISHED LENGTH
8 SAW TENON SHOULDER, EACH END, ONE SIDE
9 SAW TENON SHOULDER, REMAINING SIDE
3 INSPECT 10%
10 RIP STUBBY TENON CHEEK CUTS
11 ROUND TENON
4 INSPECT 10%
12 DRILL PILOT HOLES FOR STAPLES
5 CHECK OVER-ALL DIMENSIONS
STAPLES 3/8" 18GAGE STOCK ITEM
41 DRIVE STAPLES INTO ADJUSTMENT ROD
42 APPLY PLASTIC RESIN ADHESIVE TO SLIP MORTISE AND TENON JOINTS
43 POSITION STILE ON SHIM SUPPORTS
44 INSERT RAILS IN 2ND STILE, POSITION ON SHIM SUPPORTS
45 POSITION LOUVERS, SLIDE TOGETHER
46 POSITION & INSTALL ADJUSTMENT ROD
47 REMOVE SHUTTER
15 INSPECT 100%
HARDWARE
#99391 SEARS
48 PURCHASE
16 INSPECT 10%
49 INSTALL HARDWARE, IF REQUIRED
50 PACK IN CONTAINER

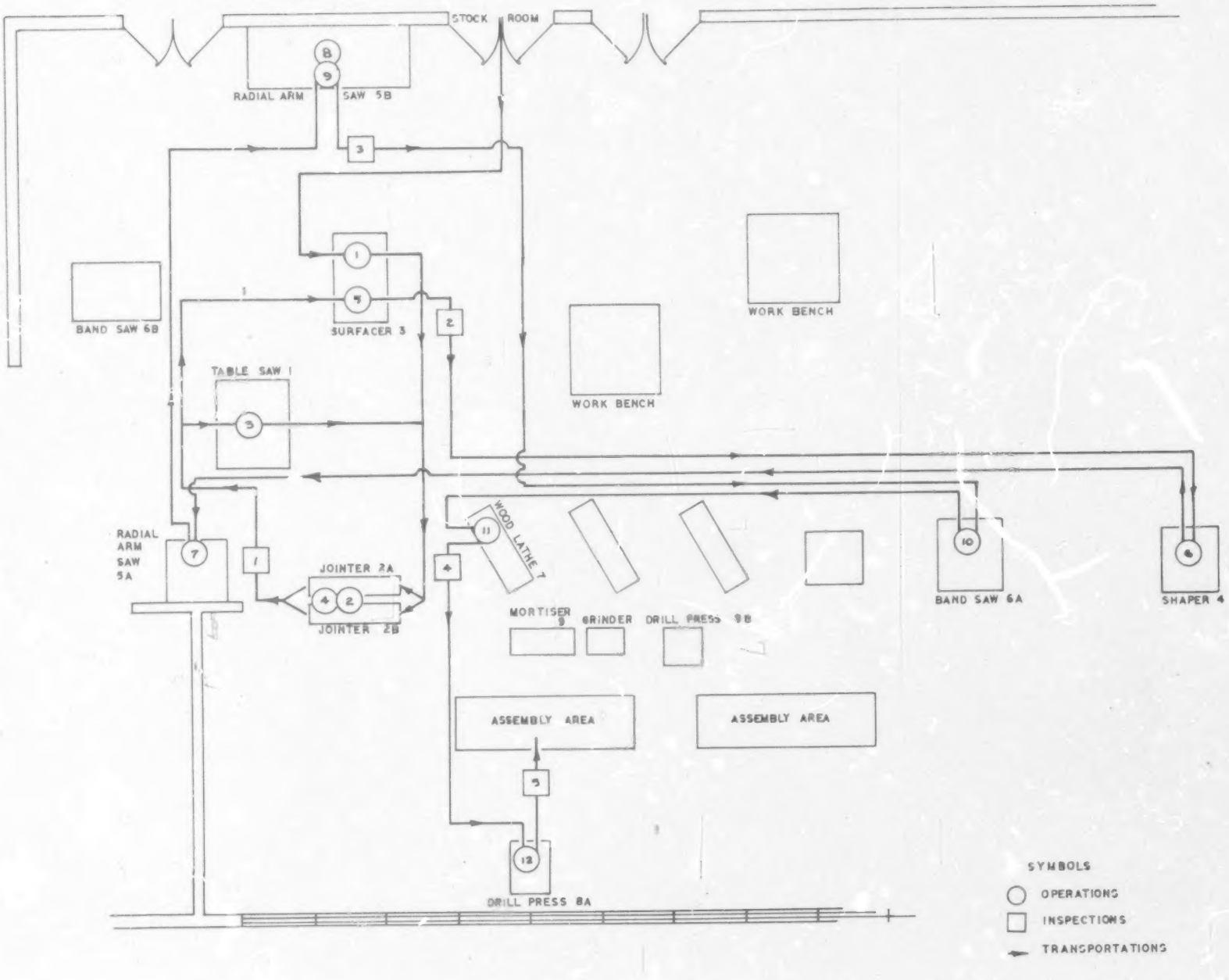
SUMMARY

EVENT	NUMBER	TIME
OPERATIONS	50	
INSPECTIONS	15	DAY WORK

FLOW DIAGRAM

SUBJECT CHARTED: LOUVERS DATE 5-70

DRAWING NO. 101-B PART NO. 101-1 JCD

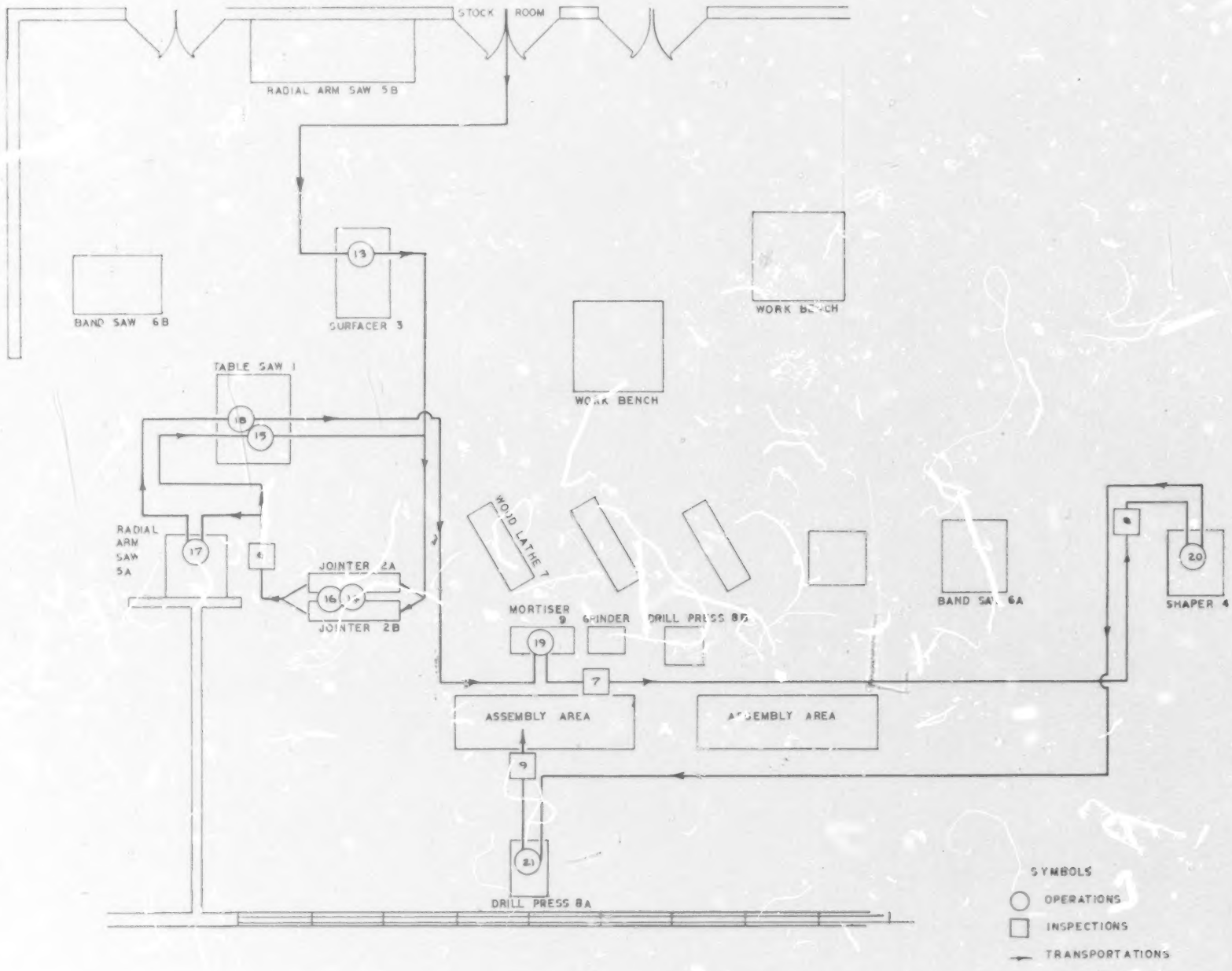


4-22

FLOW DIAGRAM

SUBJECT CHARTED STILES DATE 5-70

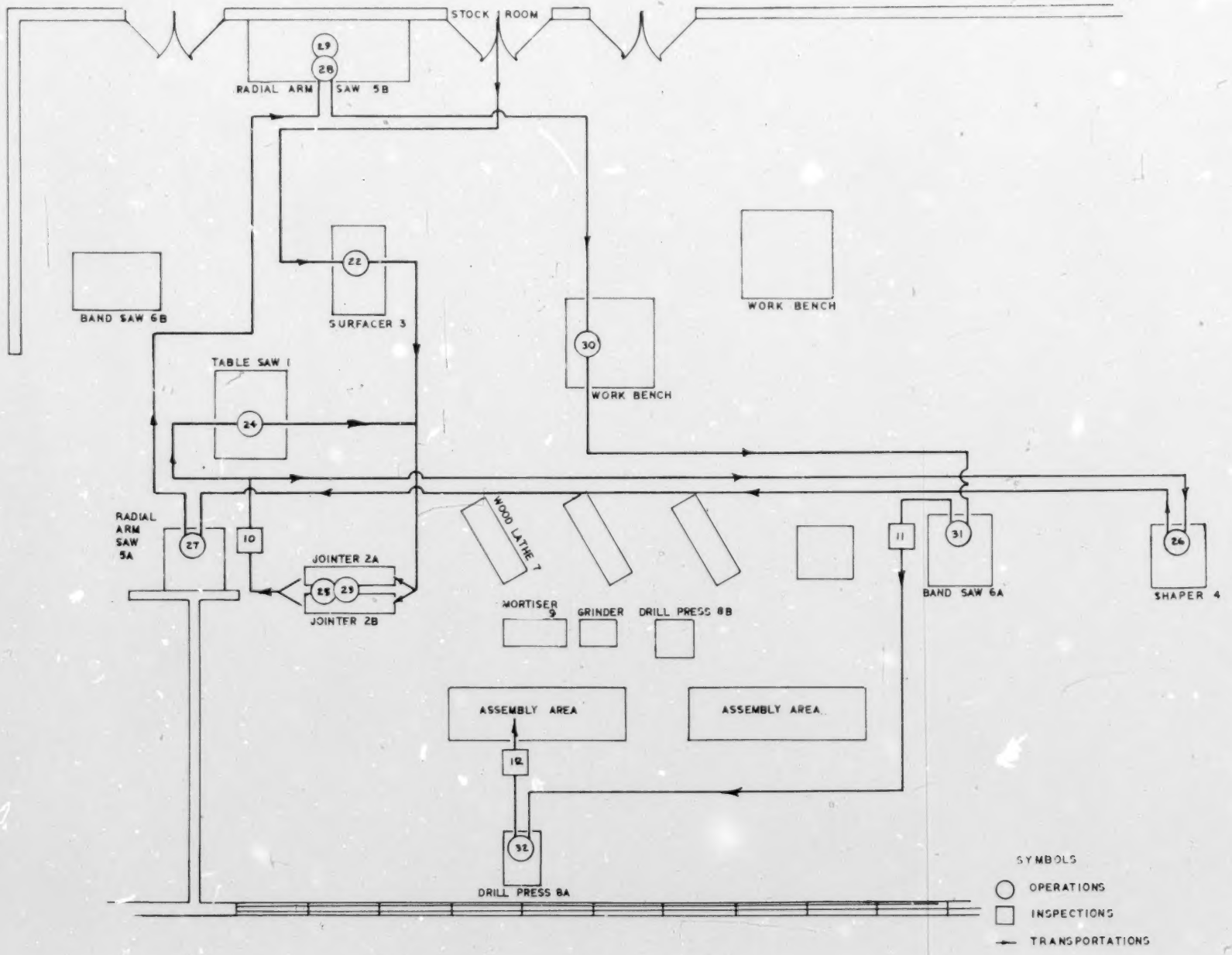
DRAWING NO. 101-B PART NO. 101-2 JCD



FLOW DIAGRAM

SUBJECT CHARTED: RAILS DATE 5-70

DRAWING NO. 101-B PART NO. 101-3,4 J.C.D.

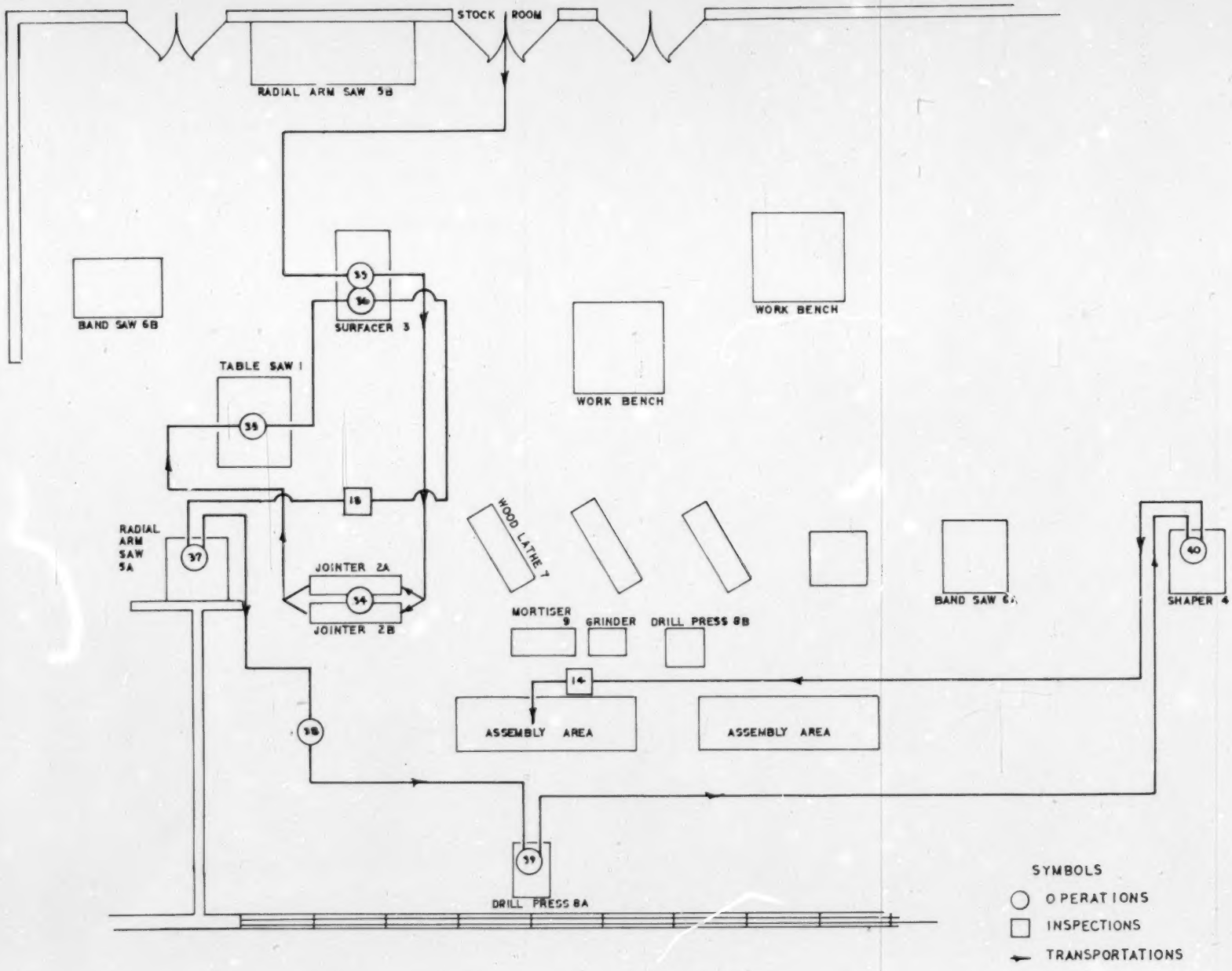


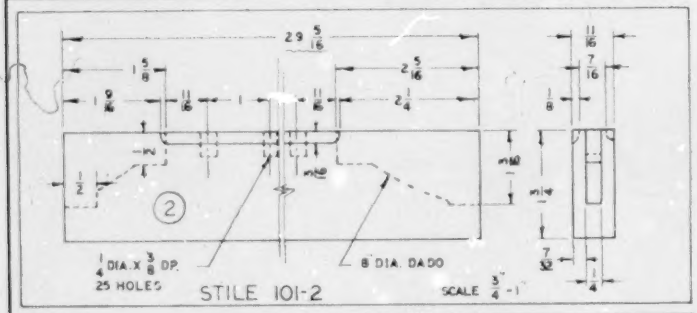
4-24

FLOW DIAGRAM

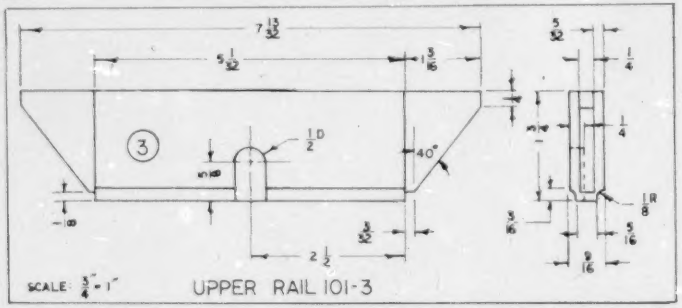
SUBJECT CHARTED: ADJUSTMENT ROD DATE: 5-70

DRAWING NO. 101-B PART NO. 101-5 JCD

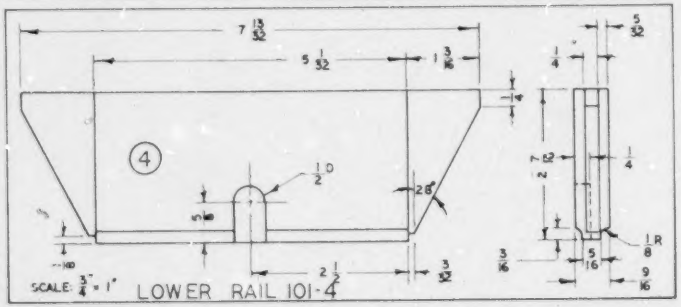




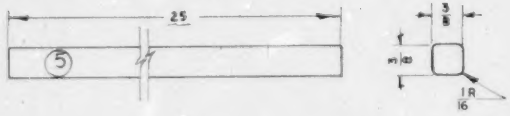
STILE 101-2 SCALE 3" = 1"



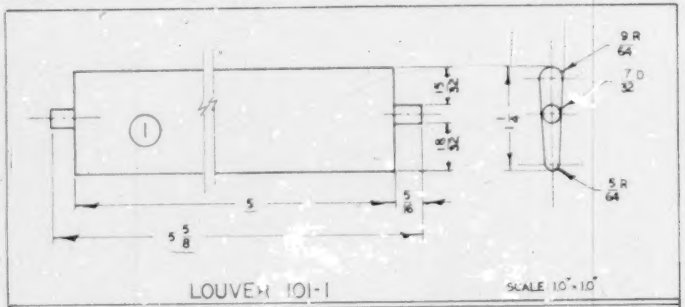
SCALE: 3" = 1" UPPER RAIL 101-3



SCALE: 3" = 1" LOWER RAIL 101-4



SCALE: 10" = 10" LOUVER ADJUSTMENT ROD 101-5



LOUVER 101-1 SCALE 10" = 10"

| | | |

V. WOOD PLASTIC COMPOSITION (WPC)

Wood Plastic Composition (WPC) is one of the most exciting developments in the wood using industry. The strength and stability of the new material overcomes many problems of wood life and durability. WPC is an example of man's ability to modify a natural resource by increasing capabilities of its application.

The combination of wood and polymers should provide an additional area for future research and a variety of new products for the woods industries. The future of the WPC process will depend upon the imagination of the users.

Wood has been the number one product for the construction of furniture and building material for many years. It is one of the worlds oldest, cheapest, most abundant, easily handled, durable, and attractive materials used for construction.

In 1868 the first plastic was researched as a replacement for the diminishing supply of certain natural materials. As early as the 1930's, plastic was used to produce products in large quantities for commerical use. Plastics could be molded into so many forms that they were rapidly taking over many of woods' traditional markets.

Wood scientists, always searching for a way to improve the properties of wood, researched the idea of compatibility of wood and plastics. To combine the characteristics of both wood and plastics was the final goal. Filling the air pockets of the wood cell structure with plastic could create a new product combining desirable features of the two materials.

Bakelite plastic was first used to create a wood plastic composition product, however the results were unsatisfactory. Absorption was uneven and the formaldehyde soaked wood was dangerous to handle. Wood dimensional stability however was achieved.

Atomic energy gave a promising new approach to the WPC process. By using gamma rays, produced by a nuclear reactor, it became possible to polymerize the plastic monomers. The gamma rays penetrate deeply without losing strength and polymerize the plastic without the use of heat. Research has been sponsored by Atomic Energy Commission as far back as the 1960's.

Dr. John A. Meyer, of the State University of Forestry, Syracuse, New York, recently developed a process that allows small businesses and schools to make WPC products without an expensive radiation process He called it the chemically initiated process, and involves using a catalyst that polymerizes the plastic by gentle heating.

Various plastic monomers can be used in the WPC process but methyl methacrylate, polystryene and polyvinyl acetate are the most popular. Some plastic monomers when used in this process develop too much heat, causing the wood to split or degrade. Monomers that are expensive, difficult to handle and those that require too much heat eliminate themselves from this procedure. Methyl methacrylate monomer at the present time seems to be the most desirable for industrial arts woods laboratories.

Scientists are now searching for new monomers that will surpass methyl methacrylate. When these new monomers are found the desirable feature should include easier handling during preparation, more uniform impregnation, greater bulking of the wood, greater strength and increased moisture resistance.

Aesthetic appeal and ease of maintenance are the two featured attractions of WPC woods. The monomers penetrate deeply throughout the wood giving a permanent build-in finish. Dyes can be added to the monomer mixture to give any color, hue or tone desired. Increased strength, hardness, abrasion resistance, durability and dimensional stability are desirable added characteristics of WPC process woods.

Light sanding and buffing removes scratches and dents from WPC woods. Wet sanding is recommended since dry sanding causes the abrasive paper to become loaded with plastic. Final buffing with pumice and or rotten stone produces a smooth, highly polished surface. WPC woods can be buffed on a muslin and/or flannel buffing wheel using Tripoli as a polishing compound.

WPC woods can be fabricated by sawing, drilling, planed and/or turned with conventional equipment. A slower rotational speed is required to prevent tools from becoming too hot and keeping the surface plastic from melting. Carbide tipped cutting tools are recommended but not essential. Feed rates must be kept high when planing WPC wood.

WPC wood chips less and is easier to work than ordinary wood. Shavings from drillings or turnings come off the wood in a string similar to ribbons; saw dust is almost eliminated.

Shrinking, warping and swelling limits the application of wood in many instances. WPC woods absorbs less water and changes less dimensionally than ordinary wood. If the new wood is used outdoors, it is necessary to apply a finish. WPC provides an excellent base for paint or lacquer.

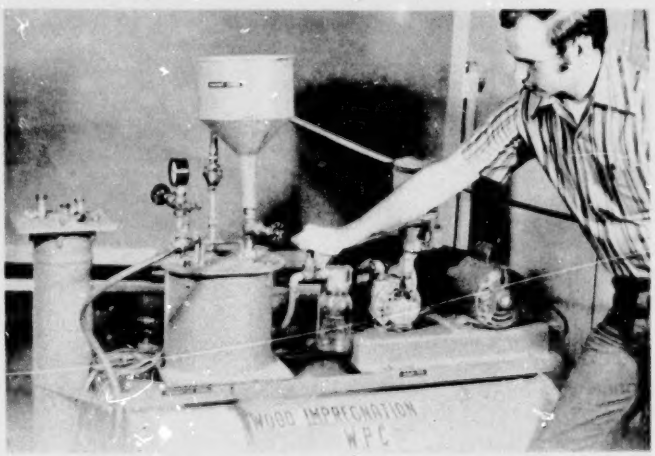
WPC woods can be glued using phenol-formaldehyde, resorcinal glues and/or expoxy cements. Contact vinyl and polystyrene cements as well as animal-base glues do not give a firm bond.

WPC processed woods have many uses. Their warmth and beauty, durability, repairability, low maintenance costs and dimensional stability make them adaptable to many products. Industrial arts woodworking students, Levels I-IV, should find many applications for the improved wood created by the Wood Piastic Composition Process.

Construction and Assembly of the Wood Impregnation Unit

I. Vessel

1. Secure steel pipe of desired diameter, length and wall section. Vessel shown in Fig. 9 measure 10'' inside dia., 10'' long and has a ¼'' wall thickness. The added vessel shown in Fig V-1 measurers 4¾ inside diameter, 2'-5½'' long and has a 3/8'' wall thickness.
2. Cut pipe to length with a power hack saw.
3. Cut off a 4'' length, secure in metal lathe and face one edge.
4. Machine a groove in the faced edge to receive ½ of the cross section of the selected sealing ring.
5. Prepare the two pipe sections for butt welding by grinding bevels on the jointing edges. Tack and weld the two sections to the desired vessel length. If a metal lathe is available to hold, square and groove the selected pipe length, omit steps 3 and 5.
6. Secure ¼'' steel plate for base of vessel, cut to size desired.
7. Tack and weld four threaded bolts (remove bolt heads), 3/8''x1¼'' long equally spaced around the top edge of the vessel pipe. Bolts should project beyond the grooved edge by 3/4''.
8. Secure ¼'' steel plate for top of vessel, cut to size desired.
9. Locate, drill and tap threads in three holes drilled through the top plate to receive ¼'' pipe nipples. Locate, drill and tap threads in a hole near the base of the vessel to receive a ¼'' pipe nipple.
10. Drill holes in top to receive vessel 3/8'' bolts.



Long and Short WPC Impregnation vessels [Fig. V-1]

11. Clean top plate and vessel of oil used in cutting threads.
12. Weld pipe (vessel) to bottom plate.
13. Apply compound to pipe threads and secure nipples in top plate and vessel side. Apply compound to pipe threads and secure the lower half of a ¼" union type coupling to pipe nipples threaded into the vessel top.
14. Thread 2nd halves of ¼" union type couplings to the vacuum gage (Marsh Instrument Co., Skokie, III.), surge tank gate valve and monomer charge gate valve (¼ 3 R. American Gate valve.). By using a union type coupling it is possible to use the monomer charge unit, surge tank valve unit and the vacuum gage on a variety of vessel styles and sizes. The valves and gages can be quickly secured to the vessel top selected as shown in Fig V-1.
15. Use thread compound when threading gate valve to drain pipe nipple.
16. The monomer charge funnel can be purchased, adapted with correct fittings and secured to the top plate funnel valve.

II. Surge Tanks

1. Secure steel pipe of desired diameter, length and wall thickness. (Tanks shown in Fig. V-I measures 3/8" wall thickness 12½" outside diameter and 3'-7" long.)
2. Secure 4 pcs of ¼" steel plate for ends of the tanks, cut to size desired.
3. Drill holes and tap threads in center of two plates to receive ¼" pipe nipples.
4. Drill holes in center of two plates to allow interconnecting tube between the two tanks, see detail 2 on drawing.
5. Clean plates of oil used in drilling and threading steps.
6. Weld end plates to surge tanks, weld interconnecting tube to tanks.
7. Secure ¼" pipe nipples to ends of tank, use thread compound.
8. Weld angle iron tray or table to top of surge tanks to receive impregnation vessel unit and vacuum pump unit.
9. Weld surge tanks to under carriage unit as illustrated in drawing.

III. Assembly of Unit Components

1. Secure vacuum pump unit (Lammert and Mann Co., #12247; R.P.M. 675; Type, SAMG, Size 1, Chicago, Ill. Unit is powered by a ½h.p., 115 volt electric AC motor.) to angle iron tray. Install on-off switch, allow sufficient power lead to reach power recepticle.
2. Install filter in line between vacuum pump and surge tank hose.
3. Install air hoses from filter to the left surge tank, from right surge tank to impregnation vessel top, and the vessel drainage valve. Secure all hose with hose clamps.
4. Secure top to vessel with wing nuts. Sealing ring should be in position as shown on detail I on drawing.
5. Connect all pipe unions couplings and secure with wrench - no compound needed. Drain valves, surge tank valve, monomer charge funnel, vacuum gage and all hoses should be connected.

IV. Test WPC Unit

1. Close monomer charge valve, open both surge tank valves, close drainage valve.
2. Switch on vacuum pump, let pump run until the vacuum gage has a steady reading at 26, should take about 5-10 minutes.
3. Close surge tank valve no. 2 and switch off vacuum pump.
4. Let the WPC unit set for 30 minutes to insure that the vacuum will hold. If the vacuum holds, the wood impregnation unit is ready for wood processing.

WPC TREATMENT OF WOOD

Before a student(s) undertakes to produce methacrylated wood he should be oriented as to the necessary equipment and materials he will use and be familiar with the procedure and sequence he should follow. A 'dry-run' is recommended to insure that: all equipment is functioning properly, materials are available, sufficient time has been allotted to complete the entire process and clean up time allowed to protect the individual, laboratory, and equipment involved.

Materials needed for a processing run are listed as follows: methyl methacrylate (monomer), vazo (catalyst), oil-soluble dye (optional), paper cups to weigh out catalyst and/or dye, containers to hold the required monomer mixture, gallon glass jars with sealable lids to store unused monomer mixture, wire grids to separate wood pieces, wood to be treated, wire basket for holding wood in the treatment chamber (optional), a metal weight to keep wood from floating, gram weight scales, heavy aluminum broiling foil, masking tape, tongs, rubber gloves and apron, face shield, measuring cups and spoons, acetone for clean up, paper towels and saw dust to soak up any monomer that is spilled on the floor.

In order to secure accurate records on each "run" in the WPC process, definite procedures should be followed. Prepare wood to be treated by the following methods: surface stock two sides, joint one edge, rip to width dimension, joint second edge, square one end (use hollow ground blade), square second end to length dimension, stamp numbers in each piece, round edges and corners (1/16" radius) with abrasive paper to avoid tearing of the aluminum foil during the wrapping step. Record dimensions, weight, species, cubic inches or volume of each piece of wood to be processed. Wood use in this process should have a moisture content of 6-8 per cent. After treatment the percentage of increased weight can be calculated for each piece of wood. If desirable results are not obtained in the first run, the procedure can be adjusted for more favorable results.

To properly determine the amount of monomer needed the following information will be helpful. The total volume of the impregnation vessel (10" dia. by 10" deep) shown in Figure 9 is *785.0* cubic inches, holds 3½ gallons and the volume of each inch in height is *78.5* cubic inches. The vessel shown in Figure V-1 (4¾" inside dia. by 2'-5½" deep) is *545.4* cubic inches, holds 2½ gallons and the volume of each inch in height is *18.8* cubic inches. One pint of methyl methacrylate contains *26.75* cubic inches and weighs *457.0* grams. One cubic inch of monomer weighs *17.1* grams.

The wood to be treated with the WPC process must be covered by at least 2 inches of monomer during the soaking period. To determine the amount of monomer required, a run was carefully checked and the procedure listed below for your convenience. The 2½ gallon impregnation vessel was used.

Six pieces of wood were prepared, weighed and the total number of cubic inches or volume was calculated to be *67.68*.

The height of the wood to be treated, plus wire grids to separate the wood was determined to be *8.25* inches high. To insure that the wood would be covered by at least 2 inches of monomer at the end of the soaking period, 4 inches was added to this number. The total height of wood to be treated plus 4 inches allowance is *12.25* inches.

The total height of the liquid calculated should be multiplied by the volume of one inch (18.18) of the vessel. The required part or volume of the vessel to be used is *222.70* cubic inches.

Subtract the total volume of the wood (67.68) from the volume of the height in the vessel (222.70) to be used; this value will be *155.02* cubic inches.

To accurately measure the mixture, convert the volume of monomer calculated into gram weight. Multiply the weight of one cubic inch of monomer (17.1) by the volume of monomer (155.02) needed; this value will be *2,633.72* grams.

Favorable results have been accomplished by using a catalyst mixture of 4 to 1000. To obtain the correct amount, multiply the amount of liquid needed by .004. The catalyst to be used will be *10.53* grams. Subtract this amount from the total gram weight of monomer (2,633.72) to obtain the new total weight of monomer needed; this value will be *2,623.19* grams.

Oil-soluble dyes will give a variety of hues and colors to the treated woods. Vary the amount as desired; it is suggested that ½ % (.005) dye on weight of the monomer would be a starting point (this step is optional).

Prepare pieces of aluminum broiling foil to wrap or fold around the treated wood after the soaking period. The wood should be wrapped immediately after removal from the monomer. The more carefully the wood is wrapped and taped the higher percentage of weight increases will be accomplished. The liquid and/or fumes of the monomer must be contained within the wood for best results.

Wire grids should be used to separate the wood under treatment, both in the vacuum and soaking steps. If the 2½ gallon impregnation vessel is used a wire basket or containing device should be fabricated to make removal of the wood easier. One piece of wood should be removed and wrapped while the other wood pieces are soaking in the monomer. If an open basket is used it will be necessary to weight the wood down to prevent floating.

The drying unit shown in Fig. 4 was used in providing heat during the hardening or polymerizing period. A separate container, double boiler type, (foil wrapped wood should be heated inside) was fitted with an easy to seal top and positioned inside the Automatic Drying Chamber. An exhaust pipe fitted into the top with a hand tightened pipe union coupled with a rubber hose extends this vent to the outside of the building. A thermometer is fitted into the removable top of the container to aid in regulating the desired temperature. The automatic drying unit used requires 3 hours preheating to elevate the desired temperature inside the container. Chamber temperature will range from a high of 177°F. to a low of 172°F. The container used for this unit was a surplus stainless steel army cooking container.

It is recommended that an exhaust fan or paint spray booth be used as a vented area for the monomer-catalyst mixing, soaking, wrapping and clean up steps. The booth should be provided with explosion proof type switches for fans and lights. Two ground wires should also be installed in this area for grounding the WPC Impregnation Unit and the monomer pouring container.

OPERATING PROCEDURE FOR WPC IMPREGNATION UNIT

1. Position unit outside vented area.

2. Position wood in impregnation vessel. Grid or wire screen should be placed in the bottom of the vessel to allow solution to circulate around wood. Place grid or screen over wood and secure with weights.

3. Secure vessel top, close vessel drain valve, open valve leading from vessel to surge tanks, close valve to monomer charge container and open valve leading from vacuum pump to surge tanks.

4. Plug power lead into 110 volt receptacle, start vacuum pump. After 5-10 minutes pumping time the vacuum gauge should read 26 and stable. Pumping time will vary with different species of wood; however, 30 minutes is adequate for most. (Check oil flow in sight holes of pump to insure lubrication if pumping unit is of this type.)

5. Mix monomer (Methyl Methacrylate), catalyst (Vazo) and dye (optional) while pump is making final draw-down. The monomer-initiation-dye solution should be mixed immediately before using. Safety pre-cautions, procedures and equipment should be used during the handling, mixing, pouring, draining, wrapping of treated wood and during the clean up. Rubber gloves and apron and a face shield should be worn; mixing of solution should be in a vented area.

6. After allowing the correct draw-down time, close valve from vacuum pump to surge tank; then turn off pump, unplug and coil power lead on unit.

7. Move Wood Impregnation Unit into vented area and attach a ground wire to the unit. (Exhaust or ventilator should be running from this point until the wood is wrapped in foil and the machine valves, lines, vessel and area is clean.)

8. Attach a ground wire to monomer-initiator-dye container before pouring mixture into monomer charge funnel.

9. Open valve to impregnation vessel allowing monomer solution to drain into vessel. Leave this valve open. Dissolved gases from the liquid will escape into the surge tank(s).

10. The monomer-initiator-dye solution should be allowed to soak into the wood for one hour.

11. Open lid on top of impregnation vessel.

12. Remove a piece of wood; carefully wrap and seal each piece in heavy aluminum broiling foil to keep solution from evaporation or bleeding out of the wood.

13. Place foil wrapped wood in explosion proof oven for 3-4 hours at 160-180 degrees. F. in order to polymerize or solidify the plastic. Methyl methracrylate is volatile and flammable so extreme caution should be used to prevent fire and/or explosion. If the Automatic Drying Chamber is used for polymerization, place foil wrapped wood in double oven unit, secure lid, connect outside vent and close chamber door. Heat sequence No. 1 should be used; this will allow air circulating fan to run only during the time the heating element is on.

14. As soon as possible, drain the monomer from the impregnation vessel (the monomer can be refrigerated for later use or disposed of by correct manufacturer's recommendations), clean vessel, valves, lines and equipment with acetone to eliminate excess fumes and freezing of valves. Cleaning can be completed during the polymerizing period.

15. Before storing unit for next production run, draw vacuum and exhaust fumes through the monomer charge funnel several times to clear gases trapped in surge tanks. For this step the unit should be positioned outside the immediate vented area but close enough for the exhausted fumes to be removed outside the building by the exhaust fan.

16. Remove wood from oven after heat time lapse, allow wood to cool to room temperature and remove wrapping foil.

17. Weigh the wood pieces to determine the percentage of weight increase. This increase in weight as well as a visual inspection will determine the success of your "run". The percentage of increase is found by dividing the amount of increase by the original weight. The six pieces processed in the above sample had the following increase in weight: hickory 20%; oak, red 38%; pine, ponderosa 19%; maple, hard 53%. Earlier runs (Fig. V-2) have produced the following percentage increase: walnut 44½%; mahogany, phillippine 98%; maple, hard 62%; ash, white 40%; ash, brown 66%; beech 47%; gum, red 77%; korina (limba) 76%; cherry 66%, engelmann spruce 137% and sugar pine 133%!

Control and Test Samples of Methacrylated Wood [Fig. V-2]

The processing of wood by the WPC chemical initiator procedure should not serve only as a woods laboratory experiment or exercise in the industrial arts program. This process should provide a new material to be used in fabricating wood products or components of products. To gain ideas as to how this new-old material can be used, read the selected references and see suggestions as to its recommended use in your industrial arts woods program.

The following articles, bulletins and references have been selected to give you a variety of techniques, processes and information.

"A New Concept in Flooring." The American Novawood Corp., Lynchburg, Va.

Cheek, Gerald. "An Industrial Education Plant for Producing Super Wood." *School Shop*, March 1969, pp. 60-63.

Decristoforo, R.J. "A Home-Shop Test of Irradiated Wood." *Popular Science*, March, 1968, pp. 166-173 and 190.

Langwig, Meyer and Davidson. "New Monomers Used in Making Wood-Plastics." *Forest Products Journal*, Volume 19, Number 11, November, 1969, pp. 57-61.

"Methacrylated Wood" and Methacrylate Monomers-storage and Handling." E.I. DuPont De Nemours and Company, Inc., Electrochemicals Dept., Willimington, Delaware 19898.

Meyer, John A. "Make WPC Materials in Your Plant." *Woodworking Digest*, 1966, pp. 35-37.

Meyer, John A. "Production of Wood-Plastic Materials Using the Catalyst Heat System." State University College of Forestry at Syracuse University, Syracuse, New York 13210.

"Modified Woods." United States Dept. of Agriculture, Forest Service, Bulletin # 2192, Washington, D.C.

Parade of the Wooden Bearings." *Oilways Publication*, 1972, pp. 7-9.

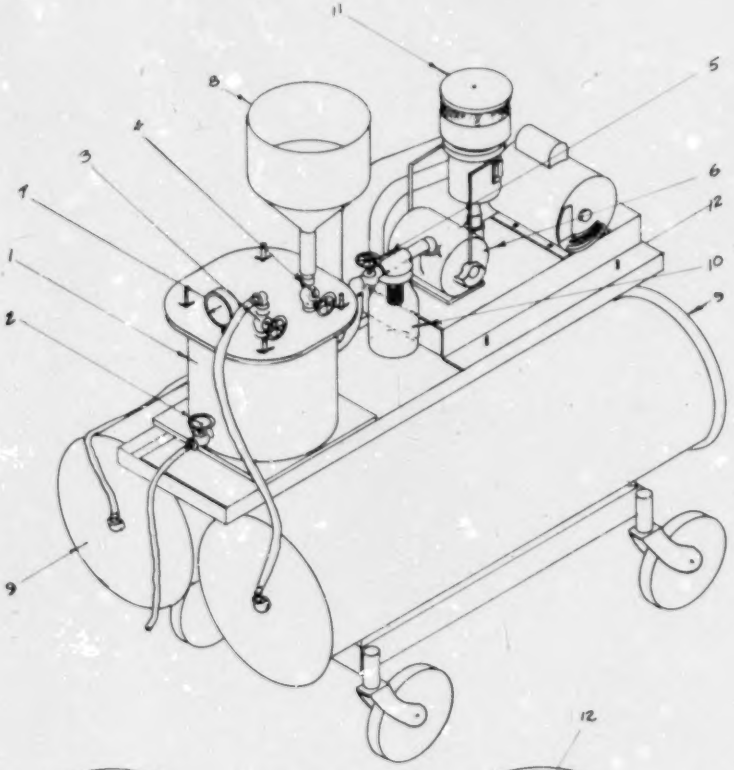
"Vazo 64." E.I. DuPont De Nemours and Company, Inc., Industrial and Biochemicals Dept., Wilmington, Delaware 19898.

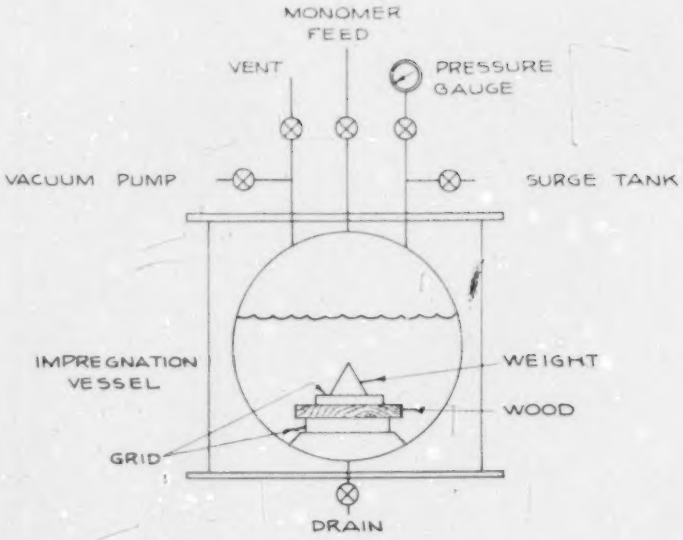
Wood-Plastic-Composition supplies can be obtained from the following companies:

Dyes - oil soluble (blue, yellow, orange, brown, and red powders are available)., E.I. DuPont De Nemours Co., Inc., Dyes and Chemicals Division, Room 1526, 7 S. Dearborn St., Chicago, Ill. 60603.

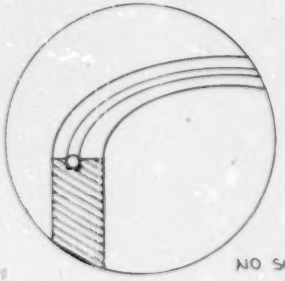
Methyl Methacrylate Monomer #H212 (with inhibitor added) 5 gal. (39 lbs) lots or more E.I. DuPont De Nemours Co., Inc., Wilmington, Delaware 19898.

Vazo (catalyst). E.I. DuPont De Nemours Co., Inc., Industrial and Biochemicals Dept., 4251 S. Crawford Ave., Chicago, Ill. 60632.



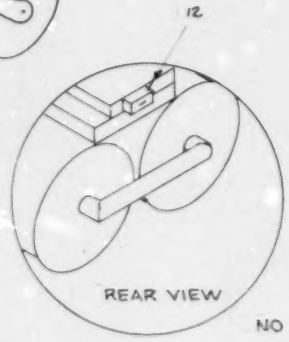


1 IMPREGNATION VESSEL - 12"DIA × 11"
2 VESSEL DRAIN VALVE
3 SURGE TANK VALVE (NO. 1)
4 MONOMER CHARGE VALVE
5 SURGE TANK VALVE (NO. 2)
6 VACUUM PUMP
7 VACUUM GAUGE
8 MONOMER CHARGE FUNNEL
9 SURGE TANK - 12"DIA × 43"
10 FILTER
11 EXHAUST
12 POWER ON/OFF SWITCH



NO SCALE

DETAIL 1. RUBBER 'D' RING SEAL ON IMPREGNATION VESSEL TO ENSURE VACUUM



NO SCALE

DETAIL 2. INTERCONNECTING TUBE CONNECTING THE TWO SURGE TANKS, AND POWER ON/OFF SWITCH

PRELIMINARY INVESTIGATIONS AND CONSTRUCTION BY STUDENTS: HENRY REED AND ART THOMAS

WOOD IMPREGNATION UNIT			
WPC			
SCALE 1"=1'-0"	REVISIONS	BY	DATE
DATE 11-2-70			
DES. JCD CHK. DCO			
DRN. OATMAN			
TITLE		DWG. NO. 1 OF 1	

VI. RESIDENTIAL CONSTRUCTION

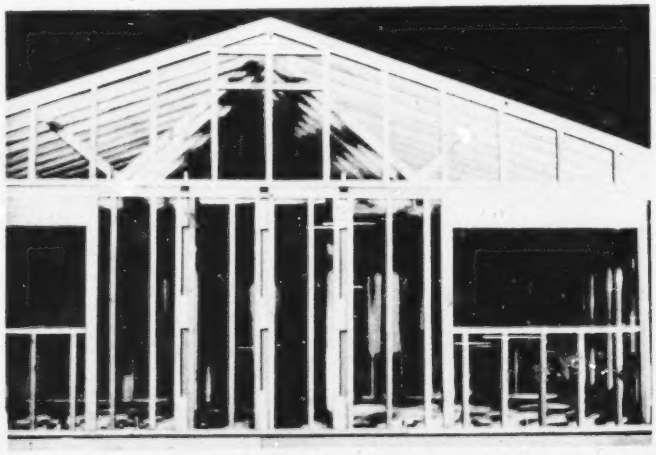
America must build 26,000 dwelling units by 1980. One half of our new homes are wholly or partially pre-fabricated, then shipped to the building site. By 1975, prefabricated or manufactured construction of housing is predicted to be over 75 per cent. A large construction firm reported they could not produce a house for less than $20,000 and stay in business. Fewer houses were built in the 60's than during the 50's. A Bureau of Labor Statistics booklet entitled, "Looking Ahead to a Career", projects that there will be an employment increase of 32 percent in the contract construction industry during the decade 1965-1975. Our nation's housing problem has swelled to truly critical proportions. A new house is one of the best investments a family can make.

The above statements or facts selected from comments made by housing experts in reference books, periodicals, newspaper articles and presentations should convince the industrial arts instructor that a unit of residential construction should receive high priority in his Level II and III woodworking classes.

In a special building issue the Better Homes and Gardens magazine listed "Ten problems the building industry must face up to," as; (1) mortages and their costs, (2) restrictive building codes, (3) the will of the people means less and less, (4) superficial selling, (5) the industry lacks social veiwpoint and conscience. The first five problems listed have an indirect bearing on industrial arts woods curriculum content, however they could easily form the basis for related type course content. The second five problems listed can be more directly blended into manipulative laboratory experiences in industrial arts woodworking residential construction teaching units. These five points; (6) soaring costs of building, (7) land costs and use, (8) product quality and improvement, (9) design mediocrity, and (10) you, should form the basic foundation for a unit in construction.

Woodworking students should have a basic understanding of the commonly used framing method of house construction (Fig. VI-1) but should also realize the need for and participate in the new technology methods used in the construction "sytems" approach.

The residential construction house plans, Sheets 1-6, specifically developed for this unit will enable teams or crews of the woodworking class to: gain construction practices, organize their activities as a group, expand their knowledge of the world of work and better inform themselves of the qualities needed in the most expensive item they will purchase in their adult life.

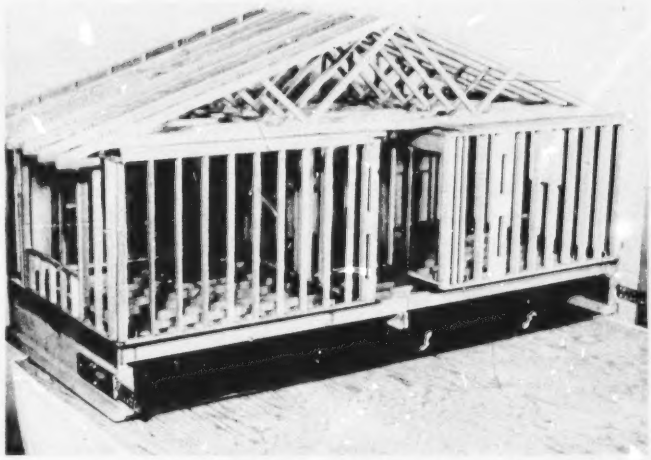


End View of Section #1 Rough Framing [Fig. VI-1]

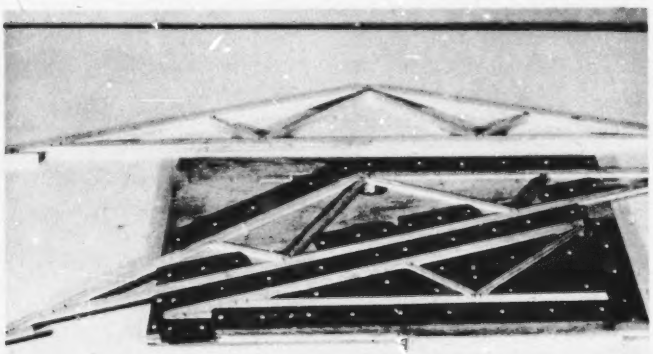
To successfully utilize machines, laboratory space and aid in student self organization it is suggested that a fourth of the class be assigned the responsibility of working on section No. 1 for the first quarter of the school year. (Fig VI-2) The second group of students will be assigned section No. 2 for the 2nd quarter, 3rd group No. 3 section, 3rd quarter and No. 4 group No. 4 section for the 4th quarter. It is anticipated that all sections will not be finished to the same degree of completeness. Only one section of the house should be under construction at one time.

A suggested crew's (6 students?) work or duty assignment could be: *one* student as a foreman or leadman; *one*

student in charge of ordering and delivering lumber to student crewman (additional duties could include cutting to length cripples, headers, braces, trimmers and nailers as required for the door and window rough opening components); *one* student cutting and assembling the foundation, post and footings, girder and sill plates and securing a ¼ inch hardboard sheet to the foundation footing to be used as a spacer and component storage floor); *one* student setting up the floor frame (header and rim joists, flooring joists, bridging and sub floor); *one* student assembling wall sections, window and door rough framing components and partitions; *one* student cutting roof truss



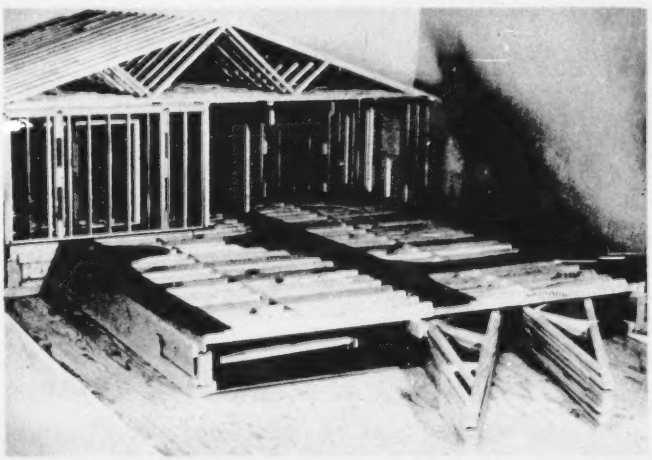
Assembled Framing Unit, Section #1 [Fig. VI-2]



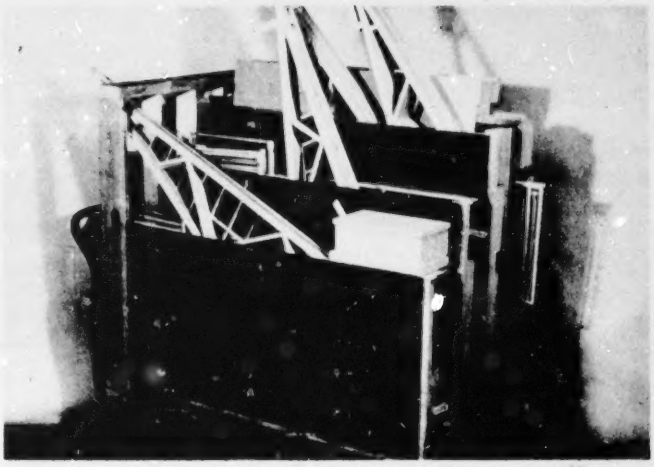
Roof Truss Assembly Jig [Fig. VI-3]

components and assembling the trusses in previously prepared jigs. (Fig. VI-3) As the various crew members complete their first assignments, the foreman should reassign them into the assembling and finishing out the portion of the section they have been assigned. No student should work on the same job area of the house more than four class periods; a work detail rotation will be of more educational value.

After each student crew completes their house section or the school quarter ends, the house components above the floor frame should be removed by units and stored in the foundation base. (Fig. VI-4) Sections above the floor frame should be designed for pinning together rather than be a permanent structure. This method of assembly will take up less IA laboratory storage space, and again project the idea of one type of "systems" approach to construction. Speedy type rivets have proven to be ideal for quick assembly pins. At the end of the school year or when desired for instructional purposes the various sections can be removed from storage, (Fig. VI-5) reassembled and moved into position to show the residential construction unit in its entirety. (Fig. VI-6) This method of house section construction will avoid the overcrowding of the laboratory area and machines. While one quarter of the class is working on the housing unit the balance



Stored Components of Section #3, Section #2 and #1 Attached for Alignment [Fig. VI-4]



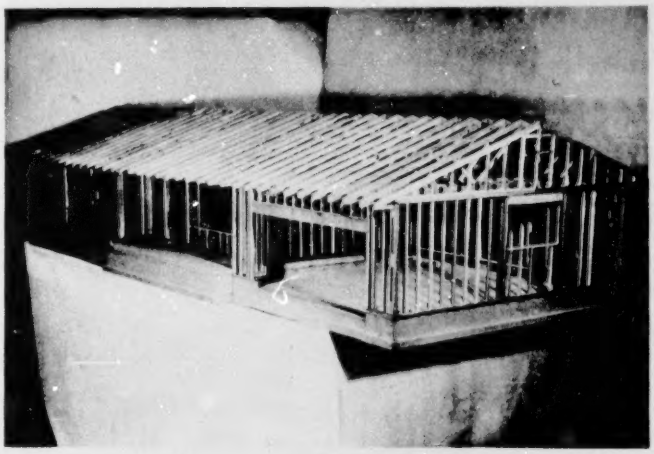
House Sections Stored Before Assembly [Fig. VI-5]

of the class can work in other areas producing products in the areas of laminations, wood flour and or particle molding, PEG processed woods and or fabricating WPC materials into useful products.

The production unit of instruction can be accomplished in part by the total class participation in manufacturing the scaled dimensional lumber for the residential construction unit. Production and use of the power machine tools can be justified at this early stage of the course as all machine operations can be well guarded with featherboards, hold down and guards. Only repetitious operations are required for production.

If all the scaled dimensional lumber can be produced at this time the machines will be free for other unit activities assigned. The summary sheet of the Materials List will be helpful in determining a final stock tally. It is suggested that an overrun of 10 per cent be manufactured for each total stock size listed.

The following methods or sequence study will be useful in setting up a class "production run" of scaled lumber. An itemized materials list will be found at the end of this unit.



House Sections Assembled to Test for Alignment [Fig. VI-6]

MANUFACTURING SCALED DIMENSIONAL LUMBER FOR RESIDENTIAL CONSTRUCTION

The following procedure has been carefully tested and the total number of stock pieces can be manufactured as listed. Manufactured scaled lumber will vary as to the total tally according to the grade of lumber selected and placement of knots in each rough length. All manufactured lumber should be clear stock. Use featherboard and fence on all band saw operations.

Procedure recommended:

1. Order 100 bd. ft. of #2 Common, Ponderosa Pine. Suggested sizes are 3/4"x11½"x16' (4pcs), 14' (1 pc), 12' (1 pc), and 10' (1 pc).

2. The following lengths will be processed in manufacturing the required stock found on the summary sheet of the material list. Spray paint the ends of the rough cut stock to be used in producing 2x4's (brown), 2x6's (black), 2x8's (green), 2x10's (almond), and 2x12's (red).

No. of pcs.	Actual Length Required	No. Stock Sizes Required	No. Stock Sizes, Final Tally	Stock Sizes
3	37"	314	358	2 x 4 x 92 5/8"studs
1	31"	60	80	" x 10's
3	43"	40	50	" x 12's
		130	145	" x 14's
2	28"	27	36	" x 16's
		13	16	" x 18's
1	37"	49	77	2 x 6 x 92 5/8" studs
1	43"	21	47	" x 12's
		17	24	" x 14's
4	25"	84	99	" x 16's
4	31"	84	110	" x 20's
1	25"	4	20	2 x 8 x 16's
1	31"	26	27	2 x 10 x 10's
6	22"	31	32	" x 12's
		25	28	" x 14's
6	25"	70	90	" x 16's
4	37"	17	47	2 x 12 x 10's
		18	26	" x 12's
1	28"	7	23	" x 14's
		2	10	" x 18's

3. Rip all ¾" x 11½" brown pcs. (2x4's), black pcs. (2x6's), almond pcs. (2x10's) color coded stock to 2 13/16" width on the band saw. Bank saw kerf, ½" blade, should be 1/16 inch. Use ripping fence.

4. Rip the ¾" x 11½" green (2x8's) color coded stock to 2 1/8" width.

5. Rip all ¾" x 11½" red pcs. (2x12's) color coded stock to 1 9/16" width.

6. Center rip all brown, almond, green and red coded stock strips on the table saw; saw kerf should be 1/8". Secure featherboard or auxiliary fence to table to insure that all stock is center ripped to approximate 5/16" thickness.

7. Surface black coded (2x6's) stock to finished (scaled) width as shown on drawing, Sheet 6 of 6.

8. Rip black coded stock to 5/16" thickness; each 2 13/16" strip should produce at least 8 pieces 5/16" thick. Use featherboard and fence on band saw for safety and to insure even cut strips.

9. Surface, one pass only, all brown, almond, green and red coded stock to dimension stock thickness as shown on drawing, Sheet 6 of 6. Do not surface thickness below actual ¼", scaled thickness would be below the safety tolerance for surfacer operation. If a surfacer is not available all stock can be produced to dimension by ripping only. This method will result in sawed surface on 2 or more sides or edges.

10. Surface black coded stock to ¼" thickness. 2x6's should now be finished dimension in thickness and width.

11. Rip brown coded stock to ½" width; each 2 13/16" by ¼" thick stock should produce 5 pieces.

12. Rip green coded stock to 1 1/32" width; each 2 1/8" by ¼" thick stock should produce 2 pieces.

13. Rip almond coded stock to 1 3/8" width; each 2 13/16" by ¼" thick stock should produce 2 pieces.

14. Surface, 2 passes required, red coded stock to scaled finished width dimension as shown on drawing, Sheet 6 of 6. (Clamp two ¾"x4" pcs. of stock to lower bed of surfacer to set up channel for surfacing of width dimension of 2x12's; 2x10's, 2x8's and 2x4's in that order. Channel should be wide enough to allow at least 10-15 pieces to be surfaced at one time. Each of the two passes should remove approximately 1/32", the second pass should remove sufficient stock to provide scaled stock width. By surfacing the widest stock 2x12's first, it will be possible to reclaim all stock that would not surface to specified width dimension. As you continue to surface stock the channel boards will require surfacing to provide table opening.

15. Repeat step 14 for almond, green and brown coded stock in that order.

16. Secure or tie all color coded strips in bundles of specified lengths to avoid excessive warping if cutting to length is not possible or desired at this time.

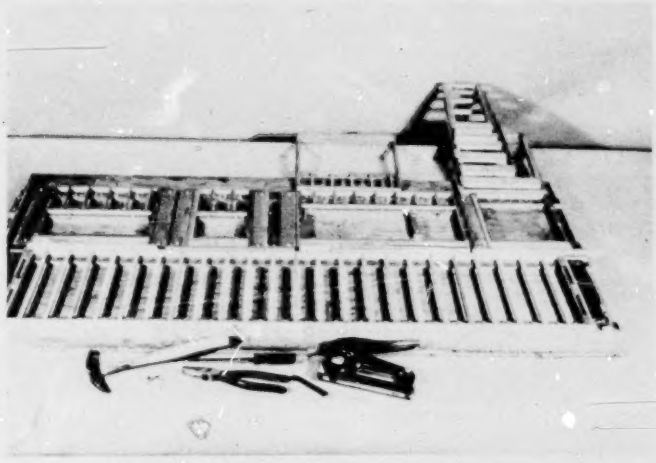
17. Cut all scaled dimension stock to length as required on summary sheet. It is suggested that the longer lengths be cut first. Allow an increase of 10% for overruns.

18. Bundle finished stock sizes and color code the ends with a magic marker. This will allow

for easy inventory as to various lengths. Suggested color code: studs-blue, 10's orange, 12's black, 14's red, 16's brown, 18's green, 20's yellow.

19. Inventory manufactured lumber and set up an inventory sheet or procedure so that the various stock sizes can be ordered by student work crews.

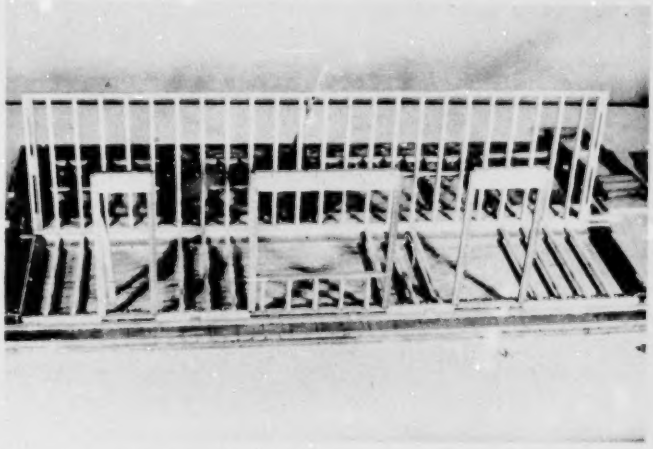
20. Square the ends of all scrap stock that could be used for cripples, braces, nailers or trimmers.



Wall, Window, and Door Component Jigs and Assembly Tools [Fig. VI-7]

Woodworking students in Levels III and IV should be utilized to construct component construction jigs and fixtures for Level II students. (Fig VI-7). These jigs should be designed to enable students to set up wall sections, rough door and window openings and trusses for fast installation in the various house sections. (Fig VI-8). This assembly method should introduce Levels II-IV to the "systems" approach used in construction. To more completely understand the new techniques and processes utilized in construction, the periodical articles selected should be read; they are listed at the end of this unit.

No attempt has been made to set up a step by step procedure for various student crews in working on their assigned sections. The references listed at the end of this unit should be studied or used at appropriate times to aid in assembly. The simple style gable roof (Fig VI-6) selected for this unit house also allows a chance for modification of section 1 and 4 to a hip type roof. By selecting and using assembled roof truss components, no load bearing walls are necessary, allowing a variety of interior floor plans to suit your class requirements.



"Systems" Approach to Residential Construction [Fig. VI-8]

The cost for all materials used in the residential house construction should be borne by the IA department and the final assembled house be retained as a teaching aid for future woodworking and drafting classes. Students may also be assigned to "finish out" the sections as time and interest permits. The house plans developed for this unit may also be quickly modified by students for each school year activity.

Material List

Foundation and footings, as a combined unit, can be produced from nominal sized Douglas Fir dimension stock; 42 linear feet are required. It is suggested that each section of the foundation and footings be strengthened by rabbeting in a ¼ inch untempered hardboard to be used as a spacer and storage floor. This will allow the space between the hardboard and floor frame to be used as storage for the various finished components such as wall frames and trusses. It is also an excellent place to store stock prior to completing the assigned house section. Sub-flooring, wall and roof sheathing, and other plywood components should be cut from 1/8 inch untempered hardboard.

Recommended tools for fabricating the various components are brad pushers, magnetic upholsters hammers and/or hand staplers. Arrow stapler, Model No. T-50, with ¼ inch long wedge pointed staples have proven satisfactory. Wire nails, flat heat, #20 gage, ½ and 5/8 inch, are suggested sizes for use in assembly.

Cutting sizes given in the material list will vary unless manufactured nominal stock sizes are held to a close tolerance. Stock sizes should be produced to scale as shown on Sheet 6 of 6, with the exception of the thickness dimension. Width dimensions have been held to ½ inch in all stock 2x4's--12's. For ease of manufacturing and assembly, the thickness dimension should not be machined below ¼ inch. Pre-cut studs should measure 92 5/8 inches; however, for ease of manufacturing and measurements, machine to 93 inches.

Sections #2 and #3 will require a spacer board between side foundation and footings to stabilize the unit while work is being completed. When all four sections are assembled at the end of the school year these spacers will not show. These spacers also complete the sections as storage units.

Subflooring for each section can be constructed from 1 piece of 1/8 inch untempered hardboard cut away to reveal foundations and the floor frame unit. It will be necessary to leave a subfloor under all partitions and wall frames to maintain correct vertical dimensions.

This material list includes only rough framing exterior materials, doors and windows. It does not include interior sheathing, finish flooring, paneling, utility materials or other items to complete or finish out the residential construction.

Item	Stock sizes T x W x L (length in ft. unless noted)	Sections #1	#2	#3	#4	Total
Foundation, walls and footings	See detail sheet 6 of 6	62'	43'	94'	138'	337'
Girder post footings	12 x 12 x (varies)	1	2 1/2	2 1/2	0	6
Girder post (laminated)	4 pcs. 2 x 10 x (varies)	1	2 1/2	2 1/2	0	6
Girder, floor	2 x 10 x 12 2 x 10 x 14	 3	5	6		11 3
Sill plate	2 x 6 x 12 2 x 6 x 14	3 2	4	4	10	21 2
Joists, header	2 x 10 x 10 2 x 10 x 12 2 x 10 x 14	 2	2 2	 4	 4	2 10 2
Joists, rim	2 x 10 x 10 2 x 10 x 12	 3	1		1 3	2 6
Joists, floor (end to end (butt) joint over girder) (end to end (butt) joint over girder)	2 x 10 x 10 2 x 10 x 14 2 x 10 x 16	 22	 30	 18 18	18 	18 18 70
Bridging, floor joist, solid	2 x 10 x 10 2 x 10 x 12 2 x 10 x 14	 2	4	 4		4 4 2
Subfloor, (plywood)	5/8" x 4' x 8'	14	18 sheets	22	7	61 sheets

Item	Stock sizes T x W x L	Sections #1	#2	#3	#4	Total
Sole plate, top and cap plates	2 x 4 x 10		12		3	15
	2 x 4 x 12	6		18	12	36
	2 x 4 x 14	9	3	3		15
	2 x 4 x 16	6	6	3	12	27
	2 x 4 x 18		3			3
	2 x 6 x 12				3	3
	2 x 6 x 14	3	3			6
Floor, front porch, (1/4" hardboard)	4" x 6' x 24'			1 pc.		1
Floor, back porch (1/4" hardboard)	4" x 6' x 8'			1 pc.		1
Floor, Garage (1/8" hardboard)	4" x 24' x 24'				1 pc.	1
Studs, (pre-cut)	2 x 4 x 92 5/8"	92	88	63	71	314
(Includes studs for	2 x 4 x 8'-7 3/4"				30	30
assembling of corners & partitions, also includes pre-cut studs for assembly of door & window units - not trimmer, sills & cripples)	2 x 6 x 92 5/8"	14	13	11	11	49
Partition junctions	2 x 4 with 3-12", 2 x 4 blocks	8	6	2	3	
	2 x 4 with 3-12", 2 x 6 blocks	1	4	2	3	
	2 x 6 with 3-12", 2 x 4 blocks	2	2		1	
	2 x 6 with 3-12", 2 x 6 blocks				1	
Corners, western style	3-2 x 4 x 92 5/8" with 3-12" 2 x 4 blocks	2	3		3	
	3-2 x 4 x 8'-7 3/4" with 3-12" 2 x 4 blocks				2	
Ceiling backing (nailers)	*2 x 6 x 12	1				1
*essential only for partitions	*2 x 6 x 16	3	1			4
and walls parallel to roof trusses	*2 x 8 x 16	1	1	1	1	4

Item	Stock sizes T x W x L	Sections #1	#2	#3	#4	Total
**Can be used to position and hold trusses in place for easy removal-can also be used as nailers. (suggest they be installed for this residential construction model)	**2 x 6 x 12		5			5
	**2 x 6 x 14	3		2	4	9
Trusses, W Type						
rafter, fly	2 x 6 x 20	2			2	4
chord, upper	2 x 6 x 20	12	18	24	22	76
chord, lower	2 x 6 x 16	12	18	24	22	76
webbs & returns	2 x 4 x 12			4		4
	2 x 4 x 14	12	18	24	22	76
assembled trusses each section		6	9	12	11	38
Gable End						
studs, end supporting	2 x 4 x 14	4			4	8
chord or rafter, lower	2 x 6 x 16	2			2	4
chord or rafter, upper	2 x 6 x 20	2			2	4
assembled gable end		1			1	2
Sheathing, exterior wall, plywood (vertical application)	5/8" x 4' x 8'	18	11	14 sheets	21	64 sheets
Sheathing, roof, plywood (face grain to be perpendicular to rafters or truss chord)	5/8" x 4' x 8'	20	25	30 sheets	32	107 sheets
Soffit, plywood, (side and ends)	1/2" x 4' x 8'	4	2	3 sheets	7	16 sheets
Facia	1 x 8 x 10	2	4		5	11
	1 x 8 x 12	1		4		5
Molding for Cornice	Quarter Rd., linear ft.	60	80	96	100	336 linear ft.
Roofing, single underlayment	15 lb. saturated felt	608	703	874 (square feet to cover)	950	3,135
Roofing, #235 Asphalt shingles, double coverage, 5" exposure	12 x 36" sq.-butt strip, 3 tabs	18	21	27 bundles	29	95 bundles

Item		Stock sizes T x W x L	Sections #1	#2	#3	#4	Total
Siding, horizontal, drop style, tongue and grooved (matched pattern)		1 x 8 x Random	453	280	304	574	1,611
			(square feet to cover)				
Siding for gable ends. Paneling, tongue & grooved (matched)		1 x 6 x Random	104			104	208
			(square feet to cover)				
	No. Needed						
Window (1)		See sheet 6 of 6			1		1
Framing for rough opening *ordered earlier in material list							
Header 2 x 12 x 10'-2 1/4"	2	2 x 12 x 12			2		2
Rough Sill 2 x 4 x 9'-10"	1	2 x 4 x 10			1		1
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14			1		1
Cripple studs 2 x 4 x 1'-10 1/2"	7	2 x 4 x 14			1		1
*Studs, pre-cut 2 x 4 x 92 5/8"	2						
Window (2)		See sheet 6 of 6	1	1			2
Framing for rough opening							
Header 2 x 12 x 6'-10 1/4"	2	2 x 12 x 14	1	1			2
Rough Sill 2 x 4 x 6'-6"	1	2 x 4 x 10	1	1			2
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14	1	1			2
Cripple studs 2 x 4 x 1'-10 1/2"	5	2 x 4 x 10	1	1			2
*Studs, pre-cut 2 x 4 x 92 5/8"	2						
Window (3)		See sheet 6 of 6	2			2	4
Framing for rough opening							
Header 2 x 12 x 6'-10 1/4"	2	2 x 12 x 14	2			2	4
Rough Sill 2 x 4 x6'-6"	1	2 x 4 x 10	2			2	4

Item	No. Needed	Stock sizes T x W x L	Sections #1	#2	#3	#4	Total
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14	2			2	4
Cripple studs 2 x 4 x 3'-2 1/4"	5	2 x 4 x 18	2			2	4
*Studs, pre-cut 2 x 4 x 92 5/8"	2						
Window (4)		See sheet 6 of 6	1	2	2	1	6
Framing for rough opening							
Header 2 x 12 x 3'6 1/4"	2	2 x 12 x 10	1	2	2	1	6
Rough Sill 2 x 4 x 3'-2"	1	2 x 4 x 10	1	2	2	1	6
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14	1	2	2	1	6
Cripple studs 2 x 4 x 3'-2 1/4"	2	2 x 4 x 18	1	2	2	1	6
*Studs, pre-cut 2 x 4 x 92 5/8"	2						
Door A		See sheet 6 of 6			1		1
Framing for rough opening							
Header 2 x 12 x 3'-6 3/4"	2	2 x 12 x 10			1		1
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14			1		1
*Studs, pre-cut 2 x 4 x 92 5/8"	2						
Door B		See sheet 6 of 6			1		1
Framing for rough opening							
Header 2 x 12 x 3'-2 3/4"	2	2 x 12 x 10			1		1
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14			1		1
*Studs, pre-cut 2 x 4 x 92 5/8"	2						

Item	No. Needed	Stock sizes T x W x L	Sections #1	#2	#3	#4	Total
Door C		See sheet 6 of 6			2		2
Framing for rough opening							
Header 2 x 12 x 3'-2 3/4"	2	2 x 12 x 14			1		1
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14			2		2
*Studs, pre-cut 2 x 4 x 92 5/8"	2						
Door D		See sheet 6 of 6	2	1		1	4
Framing for rough opening							
Header 2 x 12 x 3'-5/8"	2	2 x 12 x 10	2	1		1	4
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14	2	1		1	4
*Studs, pre-cut 2 x 4 x 92 5/8"	2						
Door E		See sheet 6 of 6		1		1	2
Framing for rough opening							
Header 2 x 12 x 2'-10 7/8"	2	2 x 12 x 10		1		1	2
Trimmer 2 x 4 x 6'9 3/8"	2	2 x 4 x 14		1		1	2
*Studs, pre-cut 2 x 4 x 92 5/8"	2						
Door F		See sheet 6 of 6					2
Framing for rough opening							
Header 2 x 12 x 5'6 7/8"	2	2 x 12 x 12	2				2
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14	2				2
*Studs, pre-cut 2 x 4 x 92 5/8"	2						

Item	No. Needed	Stock sizes T x W x L	Sections #1	#2	#3	#4	Total
Door G		See sheet 6 of 6		2			2
Framing for rough opening							
Header 2 x 12 x 4'-9 3/4"	2	2 x 2 x 10		2			2
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14		2			2
*Studs, pre-cut 2 x 4 x 92 5/8"	2						
Door H		See sheet 6 of 6	1				1
Framing for rough opening							
Header 2 x 12 x 5'-1 3/8"	2	2 x 12 x 12	1				1
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14	1				1
*Studs, pre-cut 2 x 4 x 92 5/8"	2						
Door I		See sheet 6 of 6				1	1
Framing for rough opening							
Header 2 x 12 x 16'-7"	2	2 x 12 x 18				2	2
Trimmer 2 x 4 x 6'-1"	2	2 x 4 x 14				1	1
Cripple plates 2 x 4 x 16'-7"	2	2 x 4 x 18				2	2
Cripples 2 x 4 x 14 1/2"	14	2 x 4 x 18				1	1
*Studs 2 x 4 x 8'-7 3/4"	2						
Door J		See sheet 6 of 6		2			2
Framing for rough opening							
Header 2 x 12 x 2'-6 3/4"	2	2 x 12 x 10		1			1
Trimmer 2 x 4 x 6'-9 3/8"	2	2 x 4 x 14		1			1
*Studs, pre-cut 2 x 4 x 92 5/8"	2						

SUMMARY MATERIAL LIST

Item	Stock Size	Total
Foundations & Footing	Sheet 6 of 6	337 linear feet
Molding, cornice	Quarter Rd.	336 " "
Section base & porch floors	1/4" hardboard	2,500 sq. ft.
Subfloor	1/8" hardboard	2,500 sq. ft.
Roofing, single underlayment		3,135 sq. ft. to cover
" , asphalt shingles		95 bundles
Sheathing, roof and sides	5/8" x 4' x 8'	232 sheets
Soffit	1/2" x 4' x 8'	16 sheets
Siding, drop	1 x 8 x Random	1,611 sq. ft. to cover
" , panel	1 x 6 x Random	208 sq. ft. to cover
Facia	1 x 8 x 10	11
	1 x 8 x 12	5
Studs, pre-cut	2 x 4 x 92 5/8"	314
Framing	2 x 4 x 10	60
	2 x 4 x 12	40
	2 x 4 x 14	130
	2 x 4 x 16	27
	2 x 4 x 18	13
Studs, pre-cut	2 x 6 x 92 5/8"	49
	2 x 6 x 12	21
	2 x 6 x 14	17
	2 x 6x 16	84
	2 x 6 x 20	84
	2 x 8 x 16	4
	2 x 10 x 10	26
	2 x 10 x 12	31
	2 x 10 x 14	25
	2 x 10 x 16	70
	2 x 12 x 10	17
	2 x 12 x 12	18
	2 x 12 x 14	7
	2 x 12 x 18	2

The following articles, bulletins and references have been selected to give you a variety of techniques, processes and information.

To receive current information on recent wood research publications send to: Information and Publication Services, U.S. Forest Products Laboratory, Madison, Wisconsin 53705, and ask that your name be placed on their publication mailing list.

"A Better House for your Money." Special building issue of *Better Homes and Gardens*, September, 1969.

American Wood Council, 1619 Massachusetts Avenue, N.W. Washington, D.C. 20036.

BOCA Basic Building Code, Building Officials Conference of America, Inc., 1313 East 60th St., Chicago, Illinois 60637.

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Kruppa, Russell. "Construction Technology in Industrial Arts." *Industrial Arts and Vocational Education*, November, 1971, pp43-46.

Lindbeck, John R. *General Industry, General Industry Laboratory Manual*, and *General Industry Workbook*. Charles A. Bennett Company, Inc., Peoria, Illinois 61614.

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Moore, Marvin and Neb Frisbie. "Systems Emerge in Building Technology." *Industrial Arts and Vocational Education*, December, 1970, pp19-20 &28.

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Smith, Harry F. "Update Woodshop Instruction via Scaled-Down House Construction." *School Shop*, December, 1969, pp48-49.

Smith, Jackie Lee and Theodore Hoppe, Jr. *Building to Scale, A Manual for Model Home Construction*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

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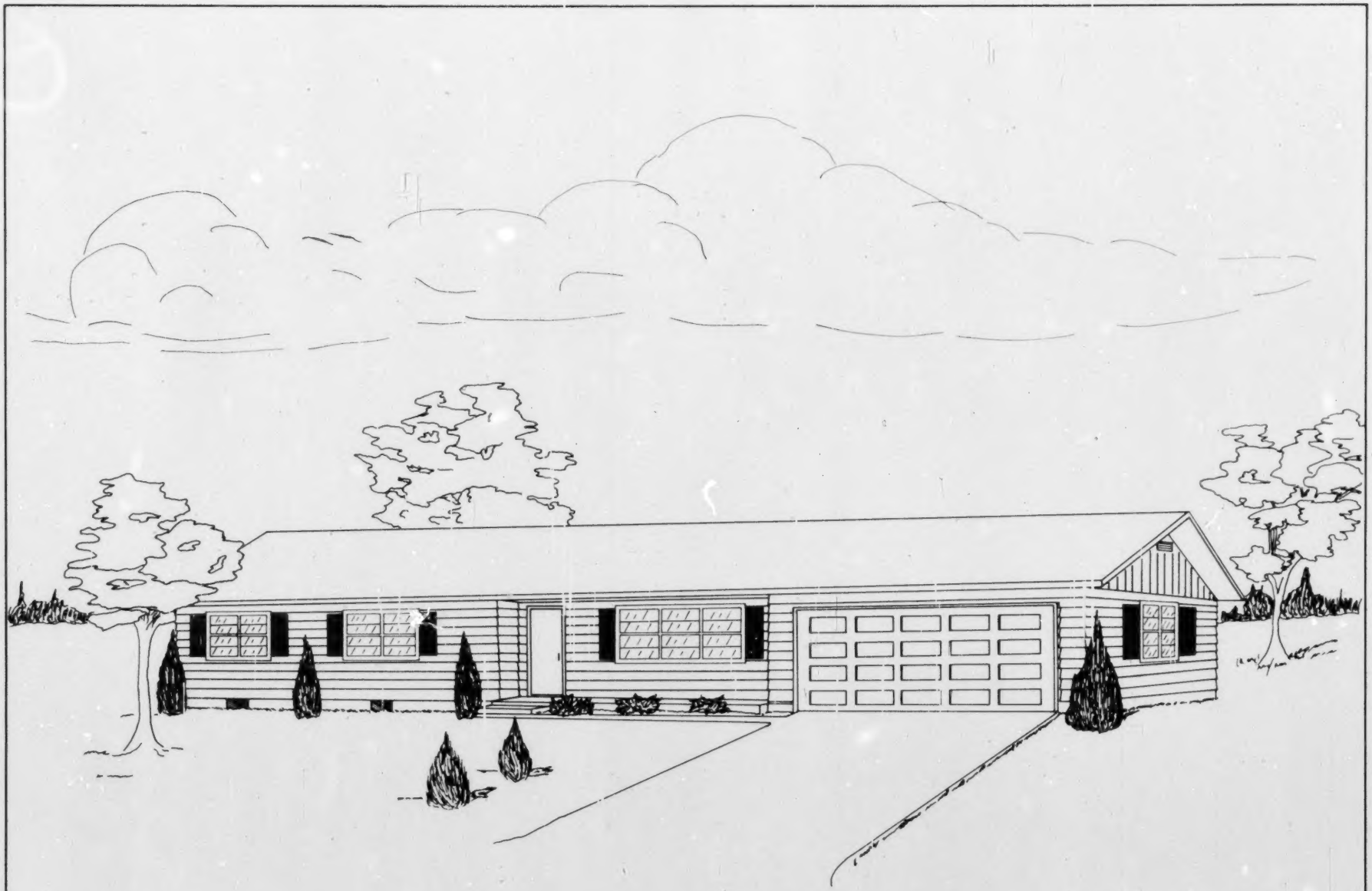
Streichler, Jerry and Marshall A. Butler. "The Manufactured Home." *Industrial Arts and Vocational Education*, September, 1965, pp36-39 & 84 & 86.

Unicom Manual #2, Fabrication of Components. National Lumber Manufacturers Association, Technical Services Division, National Forest Products Association 1619 Massachusetts Avenue, N.W. Washington, D.C. 20036.

Wagner, Willis H. *Modern Carpentry*. The Goodheart-Willcox Co. Inc.

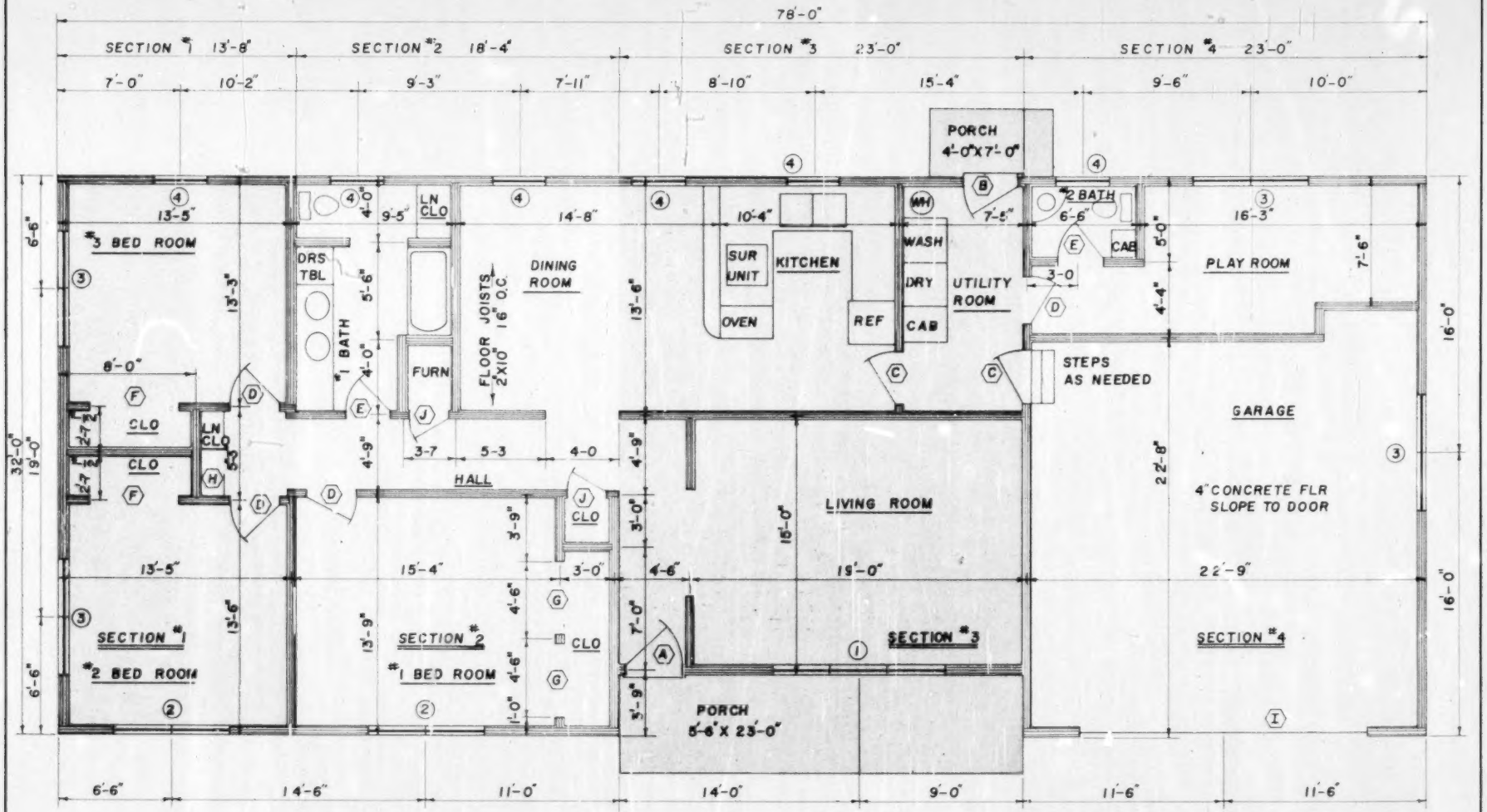
Wood-Frame House Construction, Agriculture Handbook #73 and *Low-Cost Wood Homes for Rural America-Construction Manual*. Agriculture Hand-book #364. L.O. Anderson, Forest Products Laboratory, Superintendent of Documents, U.S. Printing Office, Washington, D.C. 20402.

World of Construction, The. Industrial Arts Curriculum Project McKnight Publishing Company, Bloomington, Illinois.



RESIDENTIAL CONSTRUCTION

2 POINT PERS.	REVISIONS	OE H 1-72
DATE: 1-20-71		
DRN: DRYTON		
AP VD OATMAN		
SOUTHWEST MO STATE INDUSTRIAL EDUCATION		1 OF 6



FLOOR PLAN

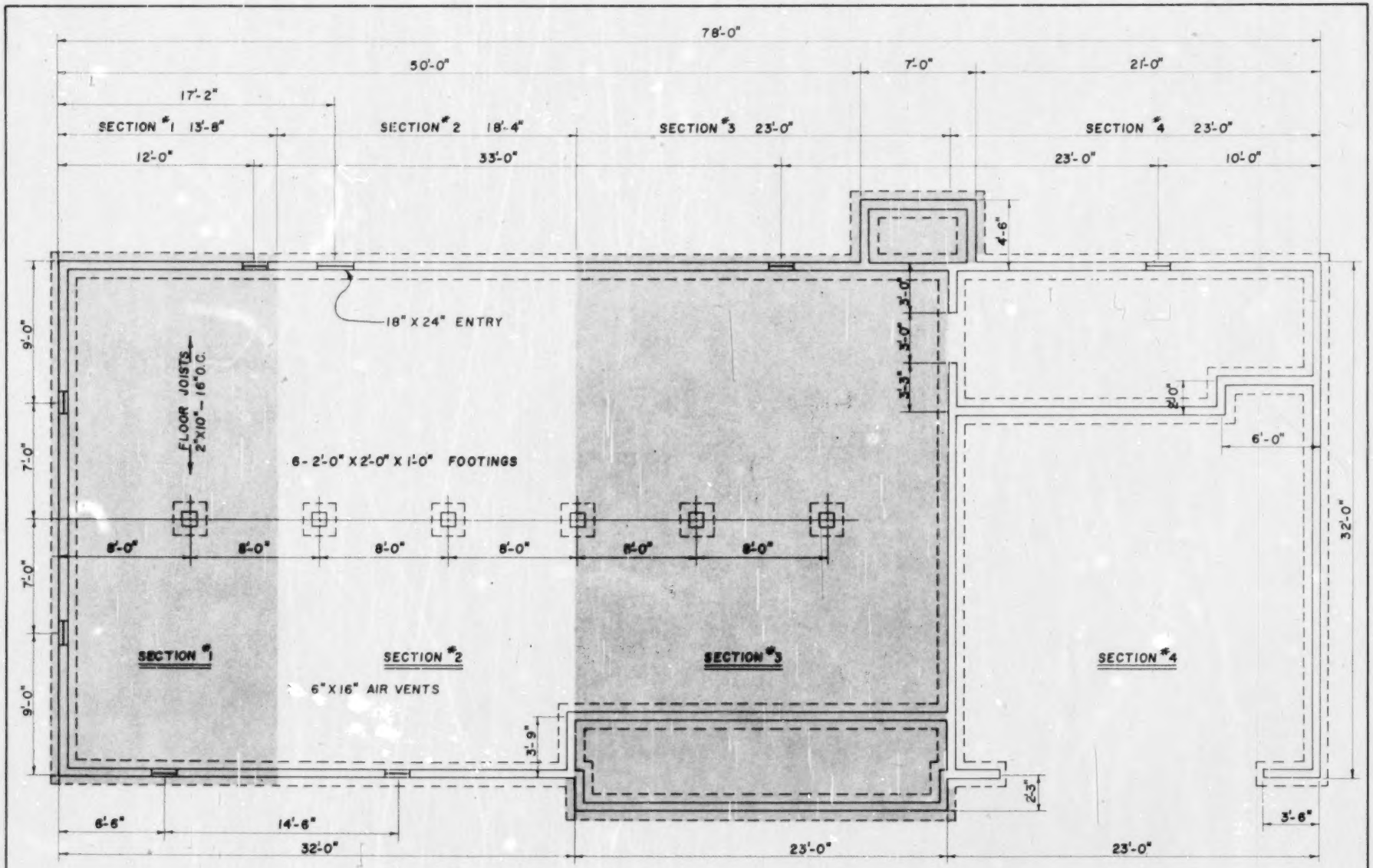
EAST

PRELIMINARY INVESTGATION

BY RAY BOLIN

RESIDENTIAL CONSTRUCTION			
SCALE: 1/4"=1'-0"	REVISIONS	OEH	I 72
DATE: 1-20-71			
DRN: PHIPPS			
AP'VD: OATMAN			
SOUTHWEST MO STATE INDUSTRIAL EDUCATION		2 OF 6	

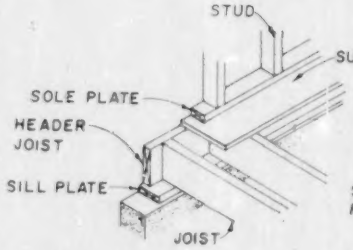
6-18



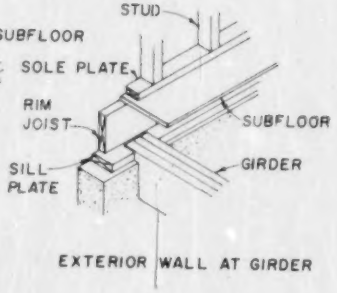
FOUNDATION PLAN

EAST

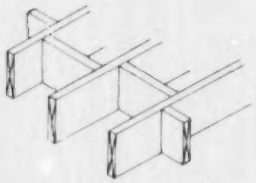
RESIDENTIAL CONSTRUCTION			
SCALE: 1/4"=1'-0"	REVISIONS	OEH	1-72
DATE: 1-20-71			
DRN: PHIPPS			
APV'D OATMAN			
SOUTHWEST MO STATE INDUSTRIAL EDUCATION		3 OF 6	



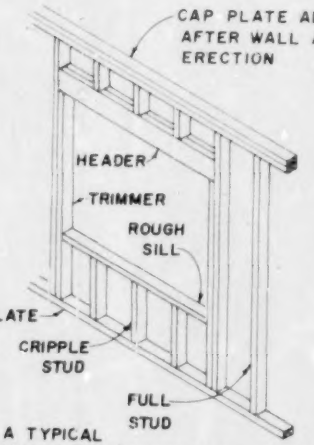
EXTERIOR WALL



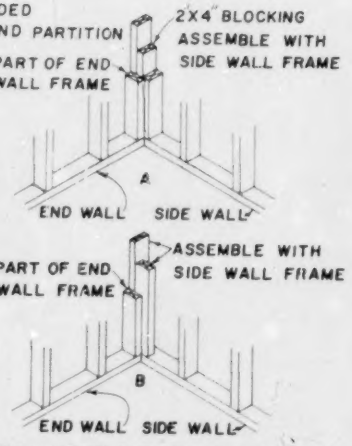
EXTERIOR WALL AT GIRDER



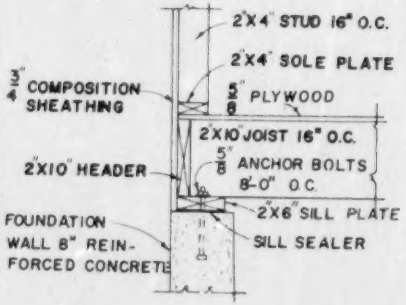
SOLID BRIDGING



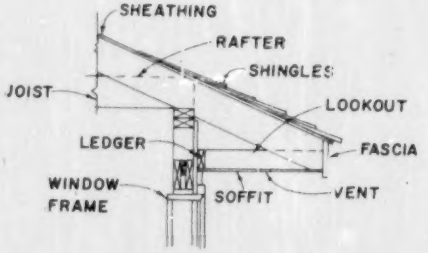
PARTS OF A TYPICAL WALL FRAME AT A WINDOW OPENING. DOOR OPENINGS ARE FRAMED THE SAME WAY, WITH THE ROUGH SILL AND LOWER CRIPPLE REMOVED (2"X12" HEADERS ARE USUALLY USED INSTEAD OF SHORT CRIPPLES.



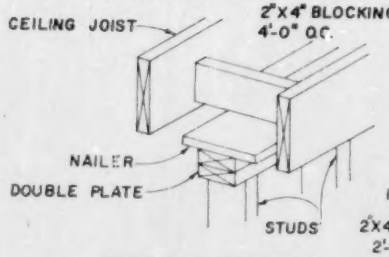
CORNER DESIGN IN PLATFORM CONSTRUCTION. A-FORMED WITH THREE FULL STUDS AND 3-2"X4"X12" BLOCKING. B-FORMED WITH THREE FULL STUDS.



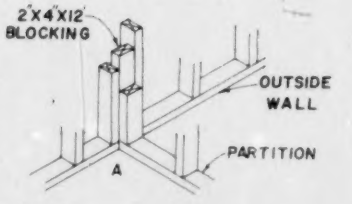
SECTION SHOWING METHODS OF CONSTRUCTION AND SIZE OF MATERIALS

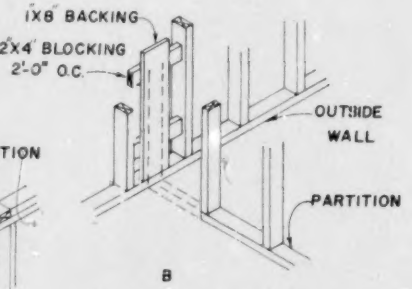


CORNICE CONSTRUCTION AND PARTS

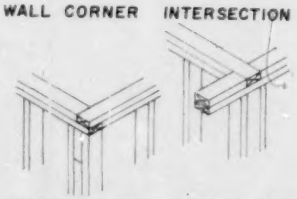


ANCHORING PARTITIONS PARALLEL TO THE JOISTS.

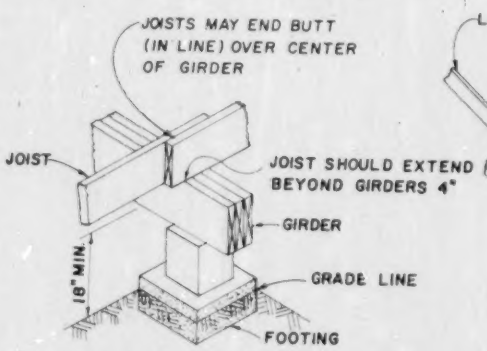




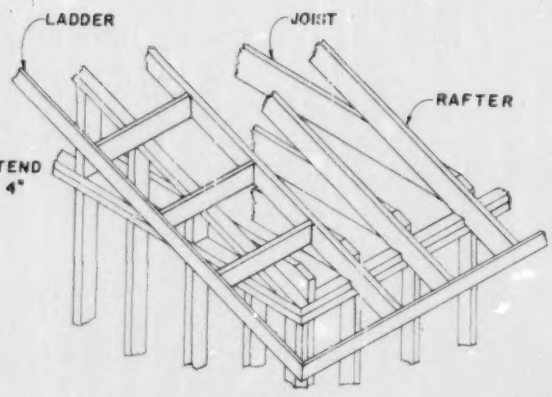
PARTITION INTERSECTIONS
A-USING EXTRA STUDS
B-USING BLOCKING BETWEEN THE REGULAR STUD SPACES



DOUBLE PLATE INSTALLATION AT CORNERS AND INTERSECTIONS



CLEARANCE BETWEEN GRADE LINE AND FLOOR GIRDER SHOULD BE AT LEAST 18" MIN.

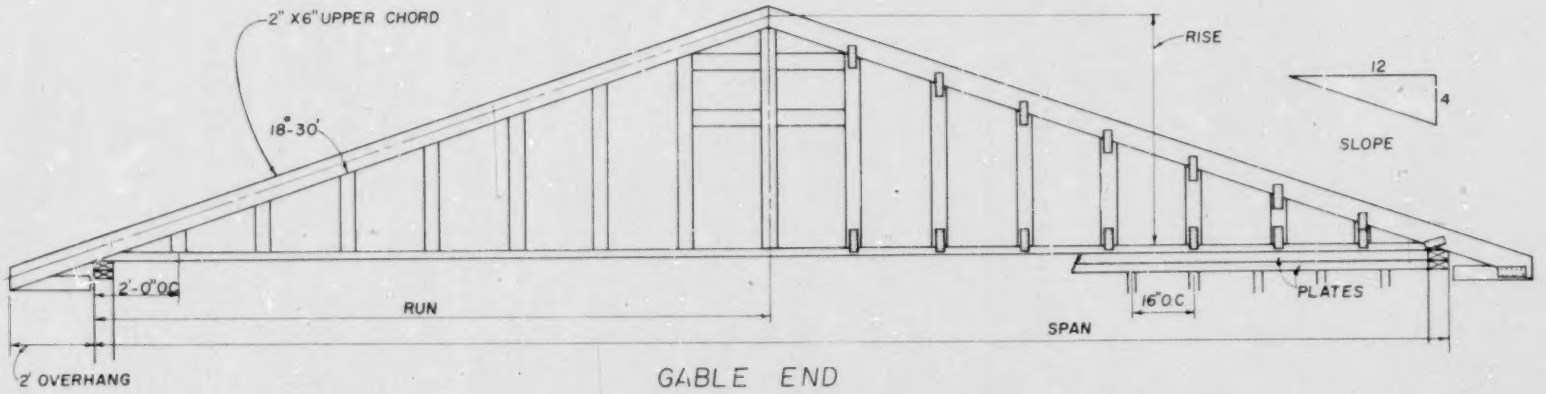


ROOF FRAMING FOR OVERHANG AT GABLE END

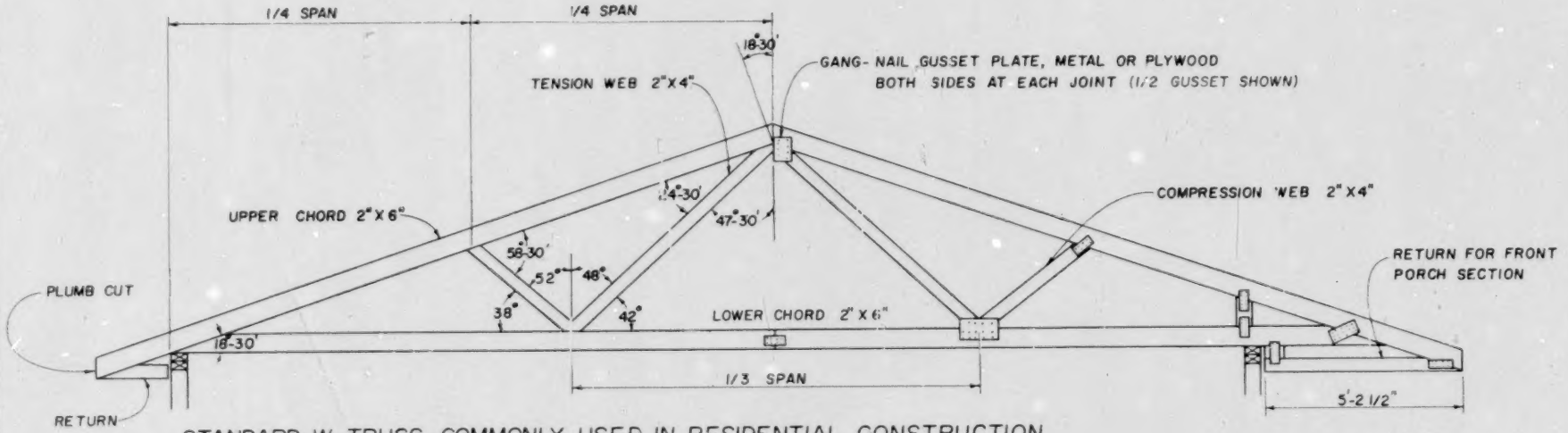
DETAILS

RESIDENTIAL CONSTRUCTION		
SCALE: NONE	REVISIONS	OEH 1-72
DATE: 1-20-71		
DWN: PHIPPS		
SOUTHWEST MO STATE INDUSTRIAL EDUCATION		4 OF 6

6-20



GABLE END



STANDARD W TRUSS COMMONLY USED IN RESIDENTIAL CONSTRUCTION

SPAN	UPPER CHORD	LOWER CHORD	TENSION WEB	COMPRESSION WEB
32'- 0"	18'- 11 3/4"	16'- 0"	7'- 4"	3'- 6"

RESIDENTIAL CONSTRUCTION

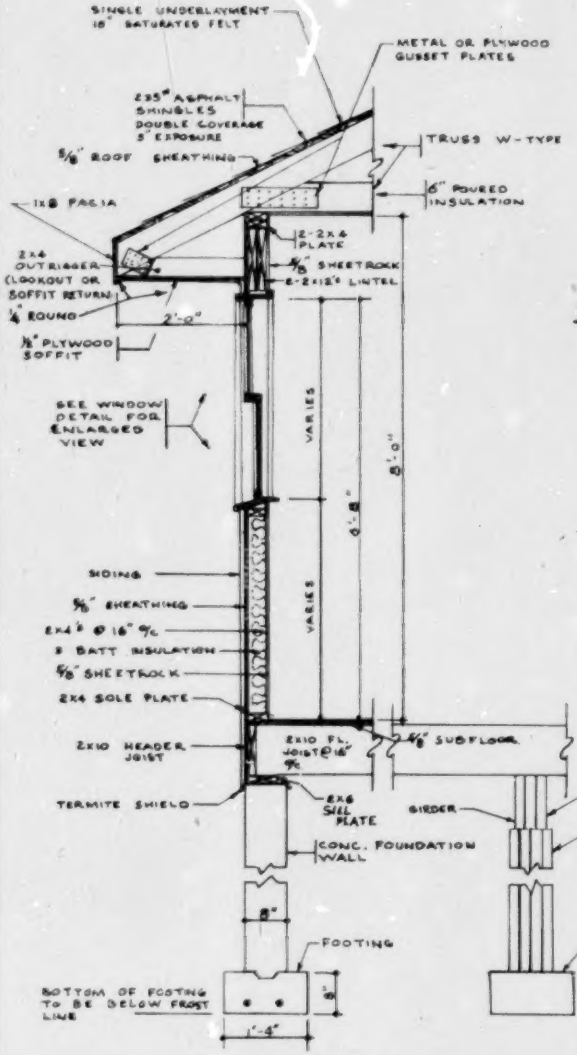
SCALE: 1/2" = 1'-0"	REVISIONS
DATE: 2-9-72	
DRN: HAGGARD	
AP'VD: OATMAN	
SOUTHWEST MO STATE INDUSTRIAL EDUCATION	5 OF 6

WINDOW SCHEDULE

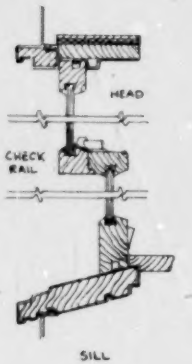
MK.	QTY.	SIZE	ROUGH OPENING	TYPE	MANUF.	NO.	REMARKS
1	1	3 - 3'-0" x 4'-6"	9'-10" x 4'-9"	DOUBLE HUNG	ANDERSON	3046	3-UNITS, NARROW MULLIONS (8")
2	2	2 - 3'-0" x 4'-6"	6'-6" x 4'-9"	↓	↓	↓	2-UNITS,
3	4	2 - 3'-0" x 3'-5"	6'-6" x 3'-5"	↓	↓	3052	2-UNITS,
4	6	3'-0" x 3'-5"	3'-2" x 3'-5"	↓	↓	↓	↓

DOOR SCHEDULE

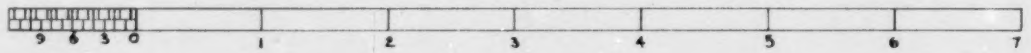
MK.	QTY.	SIZE	ROUGH OPENING	TYPE	ROOM	REMARKS
(A)	1	3'-0" x 6'-8"	3'-2½" x 6'-10½"	SOLID CORE WD.	FRONT ENTR.	
(B)	1	2'-8" x 6'-8"	2'-10½" x 6'-10½"	↓	REAR ENTR.	
(C)	2	2'-8" x 6'-8"	2'-10½" x 6'-10½"	↓	UTIL. ENTR.	
(D)	4	2'-6" x 6'-8"	2'-8½" x 6'-10½"	HOLLOW CORE	BEDROOMS	
(E)	4	2'-4" x 6'-8"	2'-6½" x 6'-10½"	↓	BATH & CLOSETS	
(F)	2	5'-0" x 6'-8"	5'-2½" x 6'-10½"	BI-FOLD 4 PANELS	BEDRM CLO.	OPEN IN CENTER
(G)	2	4'-3" x 6'-8"	4'-5½" x 6'-10½"	↓	↓	↓
(H)	1	4'-0" x 6'-8"	4'-2" x 6'-10½"	SLIDING - 2 SECTION	HALL CLO.	
(I)	1	16'-0" x 7'-0"	16'-3" x 7'-1½"	ROLL-UP GARAGE DR.	GARAGE	
(J)	2	2'-6" x 6'-8"	2'-8½" x 6'-10½"	HOLLOW CORE	HALL CLO. & PANT.	



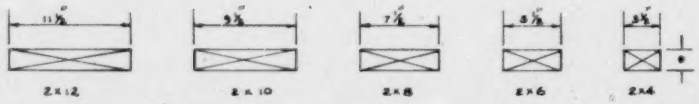
TYPICAL WALL SECTION
SCALE 3/4"=1'-0"



TYPICAL WINDOW DETAIL
SCALE 3"=1'-0"



STOCK SCALE
SCALE 1½"=1'-0"



NOMINAL STOCK PATTERNS
SCALE 1½"=1'-0"
*DO NOT REDUCE STOCK THICKNESS DIMENSION BELOW ¼" DIMENSION

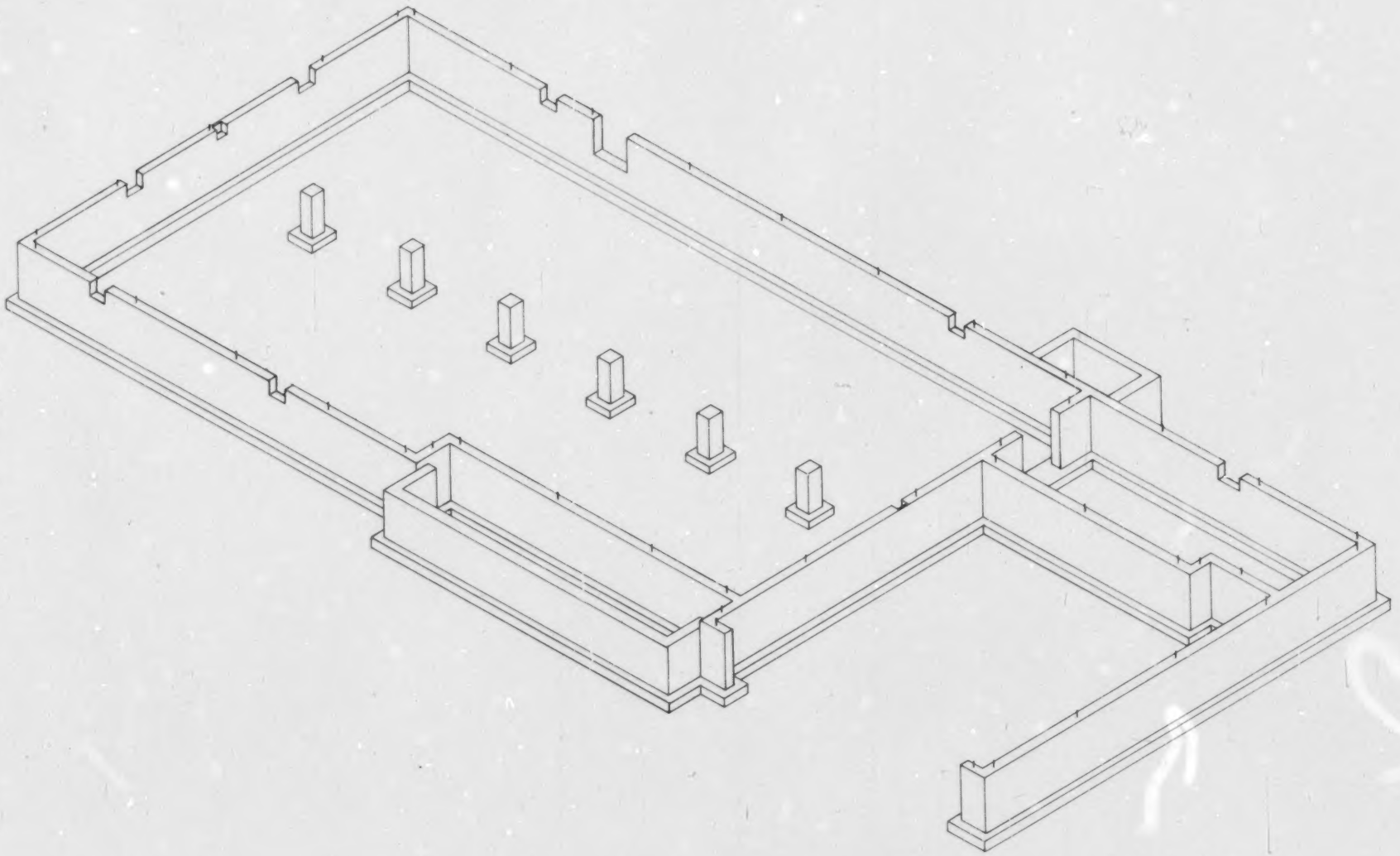
RESIDENTIAL CONSTRUCTION

SCALE	APPROVED BY: OATMAN	DRAWN BY:
DATE: 1-17-72		REVISED: Q.E.H

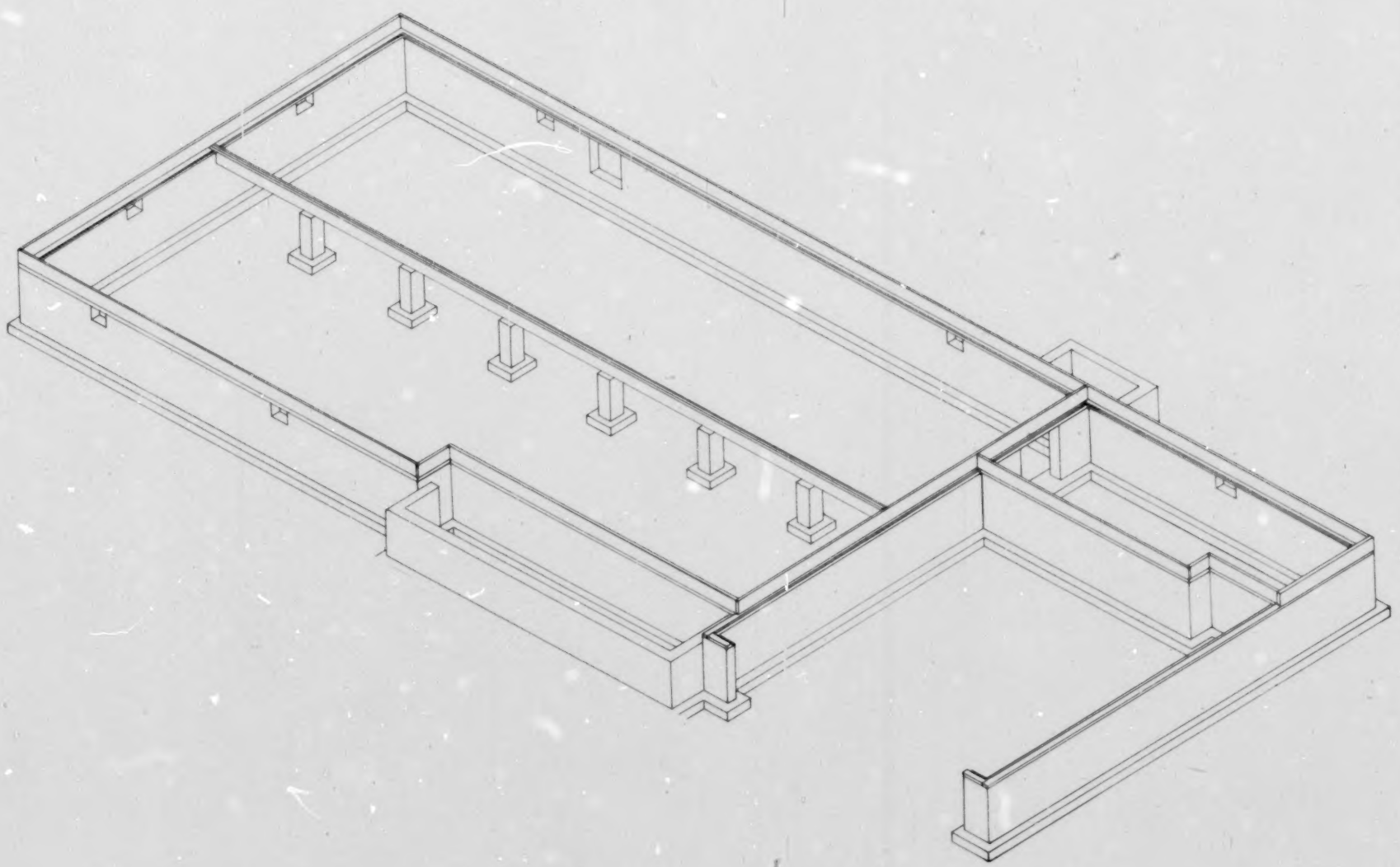
SOUTHWEST MO STATE
INDUSTRIAL EDUCATION

DRAWING NUMBER 6 OF 6

6-22

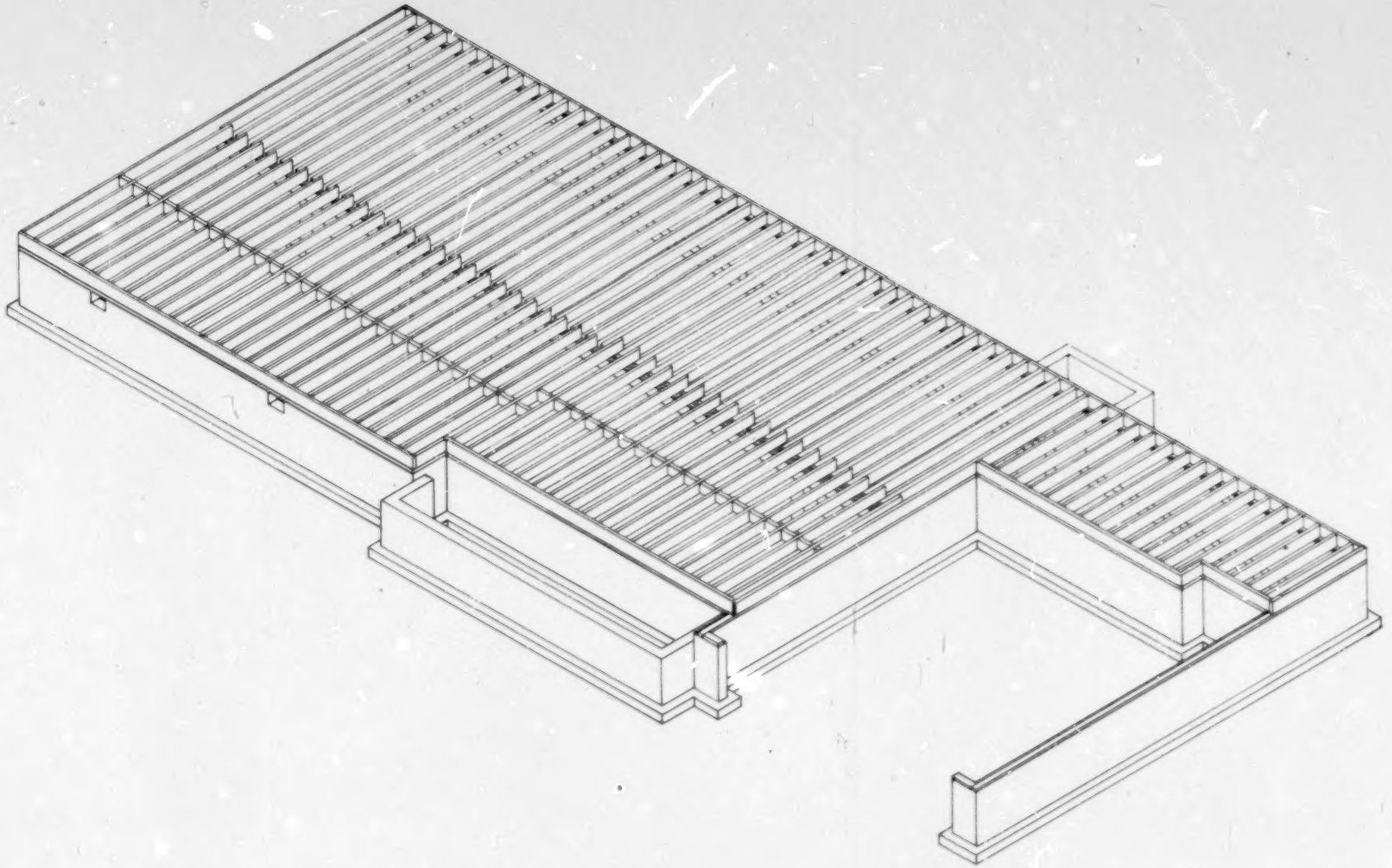


RESIDENTIAL CONSTRUCTION		
SCALE: 3/16"=1-0"	APPROVED BY: OATMAN	DRAWN BY: KEN GRANT
DATE: 1/25/72		REVISED: O.E.H.
FOUNDATIONS, FLOOR GIRDERS, POSTS & FOOTINGS		
SOUTHWEST MO STATE INDUSTRIAL EDUCATION		DRAWING NUMBER: 1 OF 6



6-24

RESIDENTIAL CONSTRUCTION		
SCALE: 3/16" = 1'-0"	APPROVED OATMAN	DWN: KEN GRANT
DATE: 1-25-72		REVISED O.E.H.
FLOOR GIRDERS, SILL PLATES, HEADERS & RIM JOISTS		
SOUTHWEST MO STATE INDUSTRIAL EDUCATION		2 OF 6



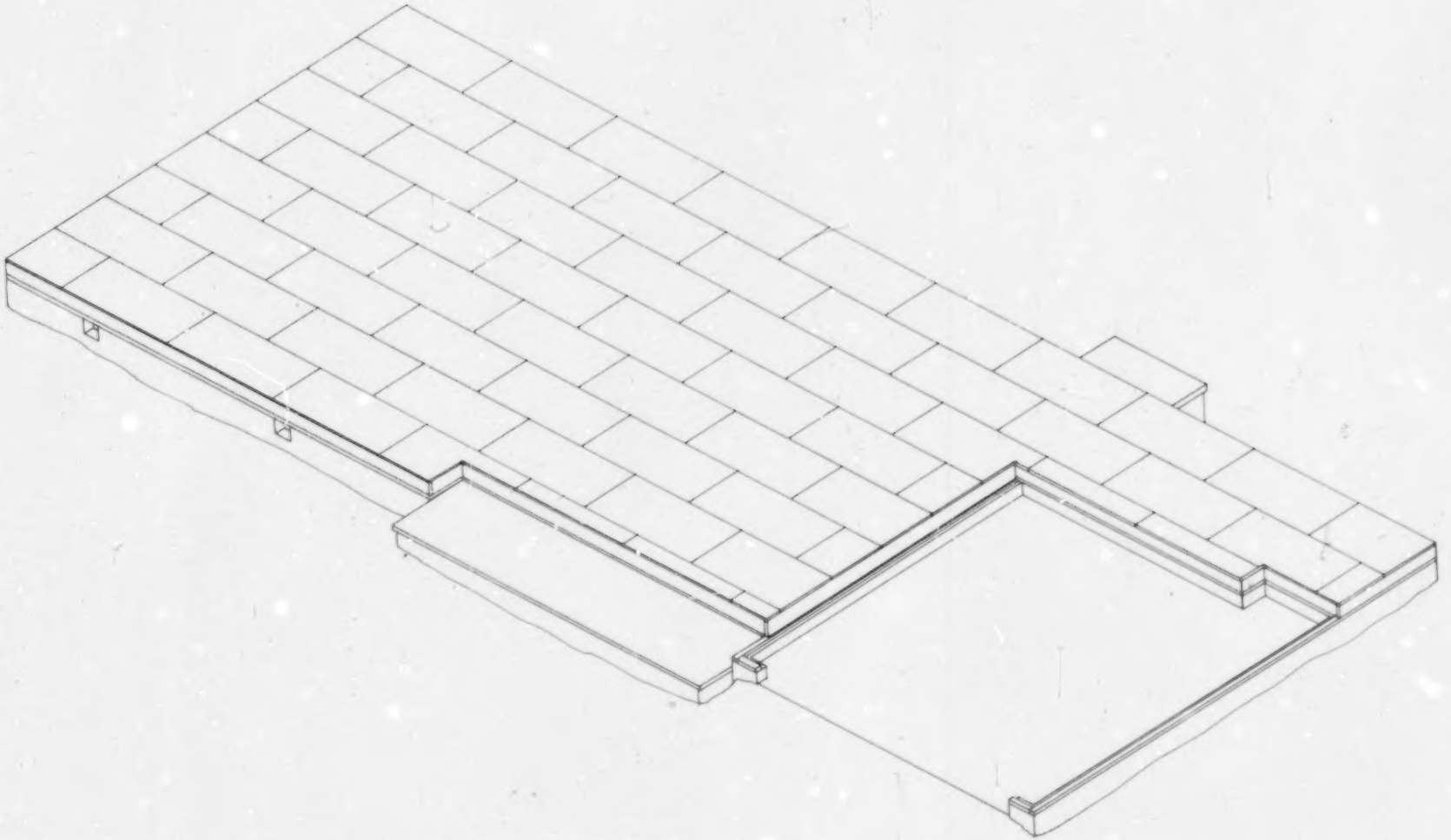
RESIDENTIAL CONSTRUCTION

SCALE 3/16" = 1'-0"	APPROVED BY OATMAN	DRAWN BY KEN GRANT
DATE 1/25/72		REVISED O.E.H.

FLOOR FRAME - REGULAR JOISTS & BRIDGING

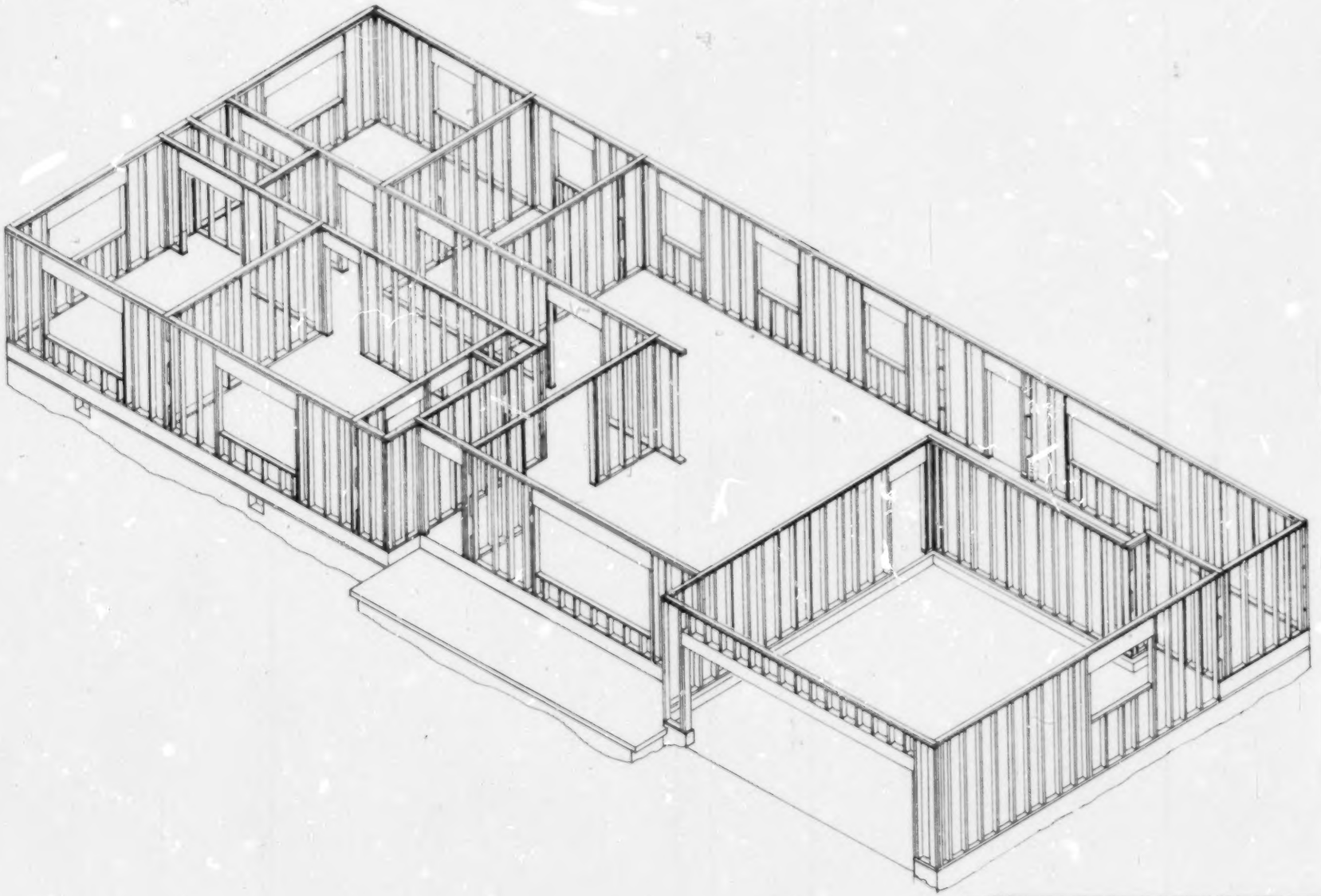
SOUTHWEST MO STATE
INDUSTRIAL EDUCATION

DRAWING NUMBER 3 OF 6



RESIDENTIAL CONSTRUCTION		
SCALE 3/16" = 1'-0"	APPROVED OATMAN	DWN. KEN GRANT
DATE 1-25-72		REVISED O.E.H.
SUBFLOOR, PLYWOOD, PORCHES & GARAGE SLAB FLOOR		
SOUTHWEST MO STATE INDUSTRIAL EDUCATION		4 OF 6

6-26



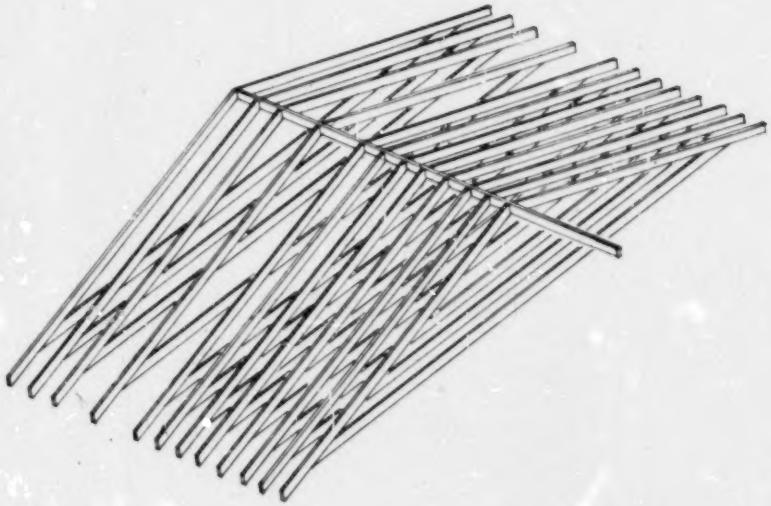
RESIDENTIAL CONSTRUCTION

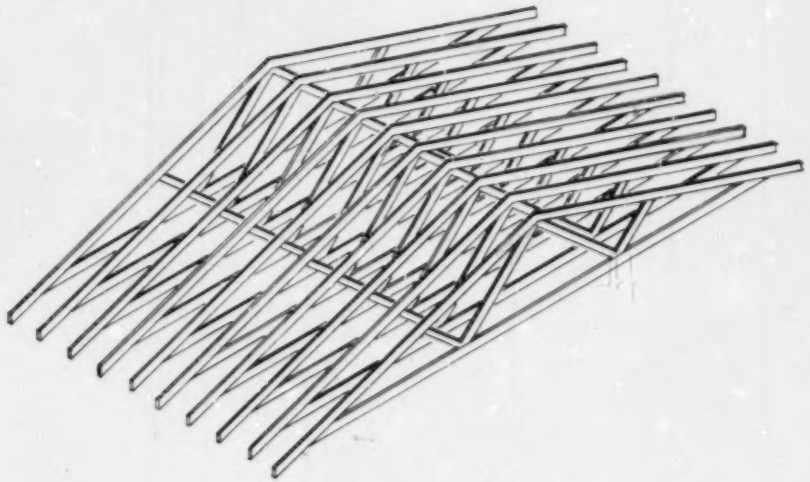
SCALE 3/16"=1'-0"	APPROVED BY: OATMAN	DRAWN BY: KROSDILL
DATE 1-17-72		REVISED OEH

PARTIAL WALL FRAME

SOUTHWEST MO STATE
INDUSTRIAL EDUCATION

DRAWING NUMBER 5 OF 6





RESIDENTIAL CONSTRUCTION

SCALE: 3/4" = 1'-0"	APPROVED BY: OATMAN	DRAWN BY: [illegible]
DATE: 1-17-72		

ALTERNATE ROOF SYSTEM

SOUTHWEST MO STATE
INDUSTRIAL EDUCATION

DRAWING NUMBER: 6 OF 6

VII. WOOD STRUCTURE, PROPERTIES & IDENTIFICATION

The soft glow of finished hard and soft woods have continued to fascinate and intrigue industrial arts woodworking students just as it did early craftsmen since the Egyptian period. Wood's natural beauty, its strength and easy working qualities are features that encourage its selection as raw materials for furniture and other useful products in our society.

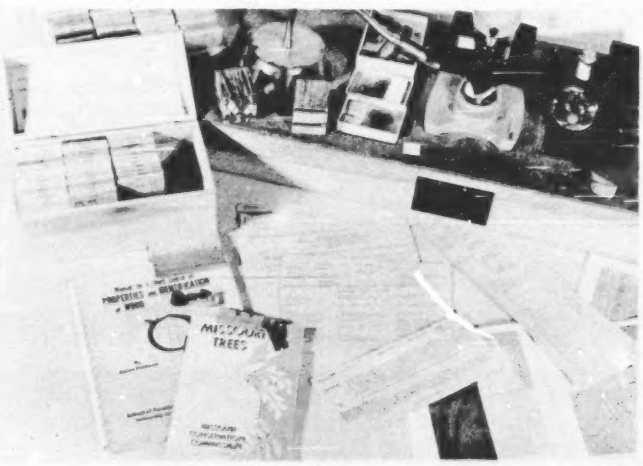
Wood is a major furniture material and today's space-age technology has made available to everyone the most elegant of hard and softwoods for fabrication into useful products. Hardwoods commonly used for industrial arts product development can be drawn from the world's resources; however, most of the favorites are Missouri grown and include: walnut, red and white oaks, black cherry, soft maple, and white ash. Other Missouri hardwoods: black willow, cottonwood, hickory, elm, yellow poplar, sycamore, sweet and black gum are also used for specialized products.

Imported hardwoods most commonly used in industrial arts programs include the true mahoganies and its substitute, philippine mahogany. It is common to find woodworking students from Level I-IV working with imported exotic woods such as ebony from Africa and Asia, zebrawood from West Africa, paldao from the Philippines, primavera from Central America and rosewood from Brazil and Ceylon. The softwoods: shortleaf or yellow pine, baldcypress and eastrn redcedar are native to Missouri and frequently are selected for constructing products in the woods laboratory.

The 26 woods listed above are but a few of the species that are used in Levels I-IV industrial arts woodworking programs in Missouri. They include ring porous, semi-ring porous, diffuse porous and non porous cell structures. Can you identify each as to genus, species, cell structure, properties and/or general characteristics? The wood study center (Fig. 11) has been designed to aid you in starting and/or continuing this important segment of your woodworking experiences.

The information cards shown in Fig. VII-1 should be completed for each specie of wood used by students in a woodworking course. A completed sample hardwood and softwood card has been included in this unit to aid you in setting up your wood study card system. The information on each card, if studied by students, should stimulate additional interest in the specific woods selected for their products. Additional books, references and bulletins are listed at the end of this unit for further indepth study. Sources for purchasing wood samples are also listed to supplement your own sample collection. To aid students in their wood study program it is suggested that you have a number of like species in your collection (Fig. VII-2). Each wood sample should be numbered and a numerical listing card as well as an alphabetical listing card should be available to the students for quick reference.

Many of our students and adults use and enjoy wood products throughout their lives with only an introductory acquaintance and understanding of the complex nature and characteristics of this common material. The American Wood Council (1619 Massachusetts Ave., N.W., Washington, D.C. 20036) in one of their recent publications, "Some little-known facts about wood", have attempted to correct this situation. The following facts have been selected from this bulletin:



Printed Materials, In-Depth Study of Wood Structure [Fig. VII-1]

I. Wood has unique cellular structure.

Under a microscope wood can be seen as thousands of hollow cells. These natural building blocks are formed from tiny cellulose fibers. About 3 million fibers are contained in one cubic inch of wood.

The cellulose fibers and the cells they form are cemented together by a natural glue called lignin. No other building material is structured in this manner.

Assorted Equipment For Wood Identification [Fig. VII-2]

II. Wood's strength is greater per pound than steel's.

A wood block one inch square and two and one-quarter inches long can support 10,000 pounds - the weight of 3 automobiles. Actually, pound for pound, wood is stronger than steel. Wood's great strength comes from the natural strength of wood's cells. The lignin that cements the cells together is not only strong, it is elastic. Consequently, wood has "give". Because of this fact wood floors are less tiring to walk on than concrete, and can bend without breaking under the stress of high winds or earthquakes.

III. Wood is a natural insulator.

It would take a concrete wall 5 feet thick to equal the insulating quality of just 4 inches of wood. Wood insulates 6 times better than brick, 15 times better than concrete and 1770 times better than aluminum.

Wood is an efficient insulator because of its unique cellular structure. Its cells contain millions of tiny airspaces and air is one of the best insulators known. A wood-frame house will keep you warmer in winter and cooler in the summer.

Wood is a valuable acoustical material. It can reflect or absorb sound waves as designed.

IV. Wood lasts for centuries.

The Old Ironworks House in Saugus, Massachusetts, was completed in 1646 and still stands as beautiful as ever. Many parts of this house are the original wood.

Wood pilings were found intact after being under the streets of Venice for 1,000 years. Timbers 2,700 years old have been found in the tomb of King Gordius near Ankara, Turkey.

Wood lasts for centuries when properly used because the lignin that cements its cells together is strong and also impervious to water and the extremes of heat and cold.

Many woods have a natural resistance to decay. Among these are redwood, cedar and cypress. Because of the cellular structure of wood, those with less natural resistance to decay, can be made more durable by impregnating the hollow cells with synthetic resins and preservatives. Bristlecone pines, extremely resinous, discovered recently in the White Mountains on the Nevada-California border are reported to be the oldest living things on earth; at this writing, 4,572 years old!

V. Some woods need no maintenance at all - even outdoors.

Wood weathers well because its cellular structure is hardly affected by water or heat; results, a soft driftwood grey. The porous cells accept stains and other finishes that can achieve different visual effects. According to government studies, hardwood floors can give more than 50 years of service.

VI. Wood's variety and uses are endless.

Wood is as varied as nature itself. Colors range from greenish black to creamy white. Grain patterns are as diverse in their rhythms as the waves of the sea. Shaped by man's hands and tools, wood takes on forms even undreamed of by nature. In spite of their diversity, wood and wood products are easy to work with.

VII. Wood is our only renewable resource.

Nature regenerates forests by removing old trees through fire, disease, insect damage or storms, and reseeds from remaining trees. This method is time consuming, however. Foresters have adapted nature's methods by harvesting trees, but use the wood to serve man's needs. Foresters replant immediately to get a new forest growing. This is why America today is nearly as forested as when Columbus landed. The wood industries plan to keep it that way--through constantly improving forestry methods and continuing research to make the most efficient use of this valuable natural resource.

The included article, "Inside a Tree" (written by Missouri Assistant State Forester, John E. Wylie and illustrated by Forester Jim Sorenson was printed in the March, 1972, issue of the Missouri Conservationist) does an excellent job in summing up this unit on Wood Structure Study.

INSIDE A TREE

By: John E. Wylie, Assistant State Forester

A stump, the end of a log or stick of fireplace wood, or the end of a board are all cross sections of a tree's life. To the knowing eye they reveal the tree's own story on how it grew, how old it is and the makeup of its cells and the role each cell played in the tree's health. Unlike animals, a tree's trunk is all skeleton with each cell being a part and bonded together in what we call wood. Reading the inside of a tree has fascinated many people. Usually only the age of the tree is seen. But there is more to see and understand.

With the aid of this combination of a drawing and photograph done by Forester Jim Sorenson we would like to show you the ABCs of tree reading.

This is a cross section of an oak tree that was cut in the late fall of 1969. Different species of trees have slightly different characteristics which also make them better for certain uses, but the basic parts of a tree are these:

1. Outer Bark: This is the outside corky layer—the skin of the tree so to speak. Insulation, protection from infections and bumps, and sealing in the tree's vital sap are its functions. On many trees, including this one, you can see grey-green patches of lichen growing on the bark. Often these colonies of lichen are as old as the tree and grow a little each year. They don't rob the tree of anything but do depend on it to hold them up to proper sunlight and moisture. In turn they provide the tree some additional protection. The ridges and fissures in the outer bark are caused by the swelling as a tree grows. The bark cracks and sometimes peels away (shagbark hickory, paper birch, and sycamore). This outer bark is continually renewed at a faster rate than it is shed. On old trees it becomes thicker and heavier and the fissures deeper.

2. Inner Bark: This buff colored layer of uniform texture is just inside the outer bark. As these cells grow old and die they turn into outer bark. As living tissue, the inner bark (technically called phloem) serves the vital purpose of transporting food manufactured by the leaves down to the roots and trunk. A tree can be killed by cutting through this inner bark in a ring all around the tree. Called girdling, this causes the roots to starve to death and then the whole tree dies.

3. Cambium: You can't see this fascinating single layer of cells without a microscope. But you can see where it is, between the inner bark and sapwood. This is the growth tissue that provides all the new cells for both wood and bark—it is where the action is. Many biological books have more detail about these amazing cells. If ever a small section of this cell layer is destroyed by a wound, all growth stops at that point until the tree can heal this wound by bridging new cells across the wound.

4. Sapwood: Also called the xylem, this one-inch-thick layer of living tissue is lighter in color than the heartwood. The sapwood is the tree's tubing that carries the water, dissolved minerals, and some stored food from the roots to the trunk and crown. When you cut or bore into this layer the tree "bleeds," and people do this to get maple syrup, rubber, and turpentine from certain kinds of trees. Even chicle for chewing gum comes from trees this way. If the sapwood is cut through by girdling the top of the tree, the tree dies quickly because it does not get water, but since the roots are still alive most hardwood trees would sprout below the girdle and start to make a new leaf system.

5. Heartwood: This is usually darker inner wood of the tree trunk. Heartwood, so useful to man as lumber, pulpwood and fuel, is of little use to the tree. It is dead, mostly nonfunctioning tissue providing only support and strength for the crown. In many old hollow trees the heartwood may completely rot away, but the tree goes on living for years if it doesn't blow over.

6. Pith: At the very center of the first annual ring is the spongy pith. In oak the pith is star-shaped reminding us of the bud and twig that was once here. As the bud grew the first layer of cells expanded rapidly. The cell walls are thin so the pith is soft and spongy.

Now let's back up and pick up a few things we have missed. The annual rings (7) are rather easy to see. Each ring represents one season's growth. Oak is a type of wood called ring porous; at each ring you can see a layer of cells which are large, hollow pores. These pores are the first cells formed in the spring when growth is rapid and cell walls thin. This layer is appropriately called springwood (8). As the growth slows through late spring and summer the cells become smaller with thicker walls, and this summerwood (9) makes up the rest of the annual ring. The strong contrast between spring and summer wood gives lumber a strong grain which shows the beautiful patterns of wood.

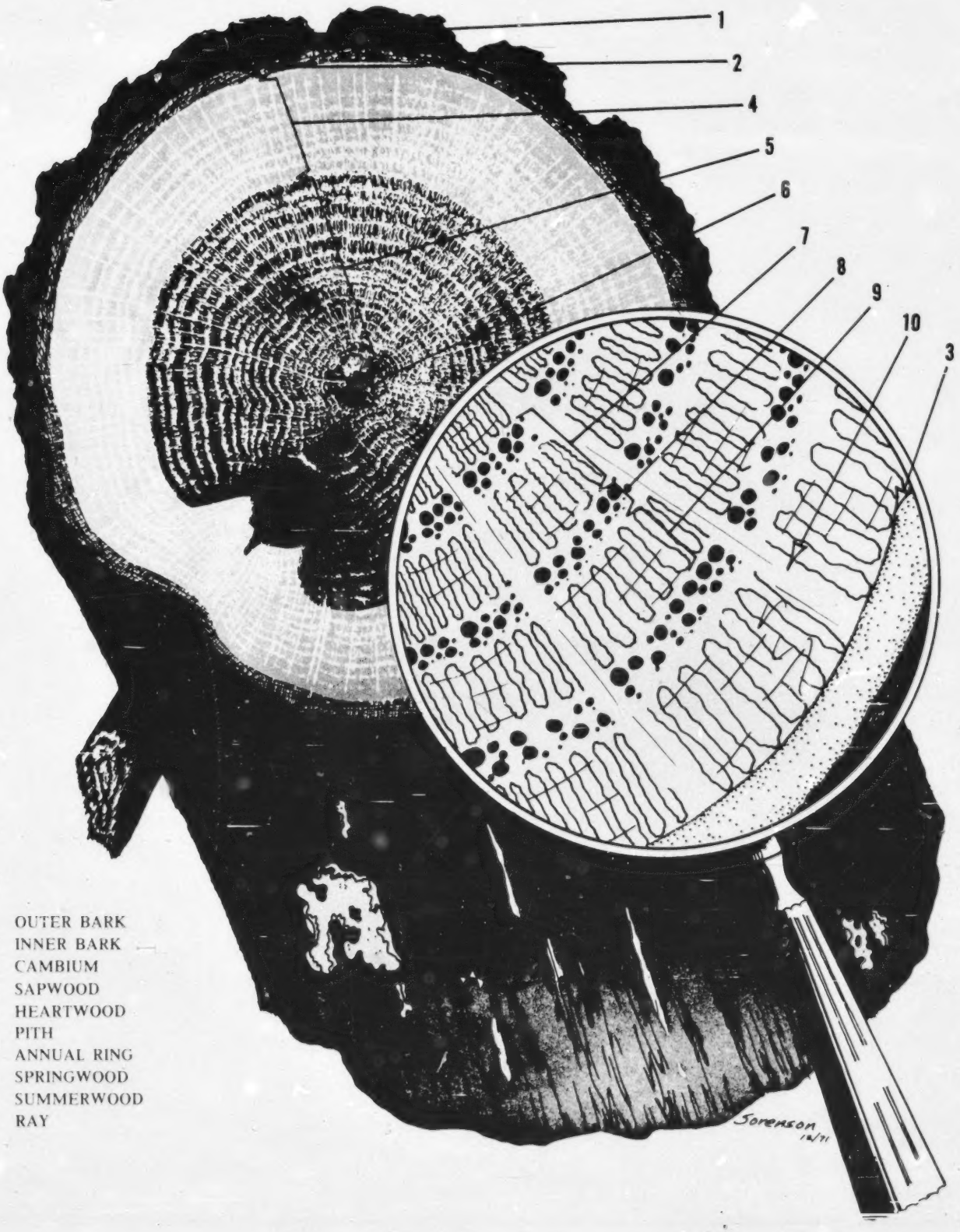
Radiating from the pith to the outer edge of the sapwood are wood rays (10). The cells in these rays are continuous from one year to the next and run at right angles to the annual rings. Many trees have rays, but they are usually not as noticeable as they are in oak. The ray cells serve to transport food and minerals crosswise in the trunk. They also serve as storage cells. When wood is sawed in the same plane that the rays run, it is called quartersawed lumber with the rays creating a ribbon effect. Wood splits easiest in this plane, at a right angle to the annual rings. Any camper or boy scout who has tried to split wood on any other angle can vouch for this.

The dark area in the lower left quarter of this tree section is a knot, the inner portion of a now dead limb. If the saw had split this knot exactly, instead of at an angle, it would extend into the pith, tapering like the point of a pencil. The knot, while the limb was living, was actually a part of the wood in the trunk with the cells knitted together. Now dead, the knot is black and loose or separated from the other wood. In a sawn board it would fall out leaving a knothole. If the dead limb is sawed or broken off flush with the bark, the annual rings will heal over the limb socket and clear wood will again be formed.

Remembering that the tree was cut in 1969, can you pick out the drought years in the early 1950s? This was a severe drought which had a marked effect on all trees. What years were wet? How old was this tree?

INSIDE A TREE

BEST COPY AVAILABLE



1. OUTER BARK
2. INNER BARK
3. CAMBIUM
4. SAPWOOD
5. HEARTWOOD
6. PITH
7. ANNUAL RING
8. SPRINGWOOD
9. SUMMERWOOD
10. RAY

SAMPLE NUMBER(S) 25, 43, 108, 132, 179, 184, 229 WOOD Walnut GENUS Juglans SPECIES Nigra

INTRODUCTION The Black Walnut is one species of a family of thirteen. It obtained its name when the Teutonic tribes secured the fruit from their Roman and Celtic neighbors and called the tree by the Angio-Saxon word "Walha" which means "foreign". From this, the word "walnut" or "Foreign Nuts" is derived. Walnut is also known as the Royal Cabinet Wood from its use by cabinet makers in furniture for reigning kings. Walnut yields twenty-three distinct types of veneer figures which are easily matched. Missouri is the leading state in production of walnut logs and has been for fifty years.

SOFTWOOD RESIN DUCTS None.

HARDWOOD PORES Semi-ring porous.

SOURCE, HABITAT Throughout the United States and southern Canada. It develops best in the Mississippi and Ohio River valleys and the general Midwest.

UTILIZATION Fine furniture, gun stocks, cabinets, novelties, gas mask, architectural woodwork, etc.

PROPERTIES OR GENERAL CHARACTERISTICS

COLOR Varying color from dark, chocolate brown in heartwood to white in the sapwood. Sometimes has a purplish cast.

ODOR, TASTE Slight unpleasant odor when wet.

HARDNESS Moderately dense and hard. Not as hard as oak, ash, beech, or hickory.

WORKABILITY Can be machined and hand-worked with excellent results.

TEXTURE Semi-ring (diffuse) porous wood and can be described as close, fine, or even textured.

WEIGHT Weighs about 3.5 lbs. per board foot when kiln dried or 38 lbs. per cubic foot

DIMENSIONAL STABILITY Excellent except under severe weathering conditions.

DECAY RESISTANCE One of the most durable woods under decay conditions.

LIMITATIONS The cost; due to travel distance to manufacturers.

FRUIT OR CONES Round, green shelled fruit used for baking and candy making.

RECEPTIVE TO ADHESIVES Very receptive to most adhesives.

FINISH CAPABILITIES Superb, unsurpassed finishing qualities.

EASE OF AND FREEDOM FROM DEFECTS IN SEASONING AND DRYING Can be satisfactorily kiln or air-dried. Holds shape well after seasoning.

FIGURE Many figure formations such as; plain, swirl, crotch, stump, or burl.

UNUSUAL CHARACTERISTICS Grows in scattered distribution; however; some small groves are discovered. The bark and husk from fruit are used to make a brownish-yellow dye.

SAMPLE NUMBER (S) 168, 226 WOOD Redcedar, Eastern (aromatic cedar) GENUS Juniperus SPECIES Virginiana

INTRODUCTION This wood is not a cedar at all. It belongs to the true Cypress family and is called a juniper. The English Literature of the early 17th century told of the virtues of the wood. Thomas Ashe wrote about red cedar and compared it to the prized West Indian or Bermudian Cedar. Benjamin Franklin in 1749 expressed concern over timber depletion and suggested use of the easter redcedar in reforestation. Franklin expressed his liking of the wood in Poor Richard's Almanac. At one time many of the southern farms were enclosed in split-rail fences of redcedar. Cedar novelties are almost trademarks of the Ozarks. Missouri is the leading producer of cedar novelties which are shipped all over the world. The French called it baton rouge or red stick. So commonly has cedar been planted as ornamental in cementeries, it is sometimes called, graveyard tree. Fragrant oils permeate the rich, red-colored wood. Since this odor repels moths and adds a welcome woodsy fragrance to clothes, redcedar is used for cedar chests and closet paneling.

SOFTWOOD RESIN DUCTS None.

HARDWOOD PORES None.

SOURCE, HABITAT Occurs over most of the eastern two-thirds of the United States. The largest production is in the southeastern and south-central states.

UTILIZATION Cedar storage chests, lining of closets and chests, pails, small articles of woodenware, lead pencils.

PROPERTIES OR GENERAL CHARACTERISTICS

COLOR Heartwood is red, sapwood is white.

ODOR, TASTE Pronounced taste and odor, pleasantly and lasting aromatic.

HARDNESS Medium density for one of softwood group.

WORKABILITY Good.

TEXTURE Fine and even textured.

WEIGHT 3 lbs. per bd. ft. kiln dried.

DIMENSIONAL STABILITY High.

DECAY RESISTANCE Highly resistant.

LIMITATIONS Rich red color tends to fade under sunlight even under a finish.

FRUIT OR CONES Small subglobose cone of 4 to 6 scales which at maturity become fleshy to form a berry-like structure, waxy-blue in color.

RECEPTIVE TO ADHESIVES Good with almost all adhesives.

FINISH CAPABILITIES Good, however, tends to fade its red color.

EASE OF AND FREEDOM FROM DEFECTS IN SEASONING AND DRYING Fairly easy to dry because most of the knots are tight.

FIGURE High because of knots in small timber.

WEATHERING Without protection it turns reddish-brown to silvery-brown. Doesn't warp or check.

UNUSUAL CHARACTERISTICS Very knotty and contains a great deal of white sapwood. Sawdust is distilled for the aromatic oils.

The following articles, bulletins and references have been selected to give you a variety of techniques, processes and information.

A Guide to the Physical & Working Characteristics of Southern Hardwoods. Southern Hardwood Lumber Manufacturer Association, Sterick Building, Memphis, Tennessee 38103.

Beautiful Woods. Frank Paxton Lumber Co., 6311 St. John Avenue, Kansas City, Missouri.

Baldwin, Robert W. "Describe Wood from an Element Visual." *School Shop*, February, 1970, p66.

Collingwood, G.H. and Warren D. Brush. *Knowing Your Trees.* The American Forestry Association, 1319 18th St. N.W., Washington, DC 20006

Classroom Demonstrations of Wood Properties. U.S. Dept. of Agriculture, Forest Service, Forest Products Laboratory, Madison, Wisconsin 53705.

Coleman, Donald G. "Retaining Woodworking in the Schools." *Industrial Arts and Vocational Education*, September, 1966, pp34-35.

Coleman, Donald. *Woodworking Factbook.* Robert Speller & Sons, N.Y.

Coleman, Donald. *Properties, Selections, and Suitability of Woods for Woodworking.* Forest Products Laboratory.

Discovering Cone-Bearing Trees. Commercial Printing Co., Visalia, Tulare County, California.

Durrell, Glen R. "Written in a Tree." *Missouri Conservationist*, October, 1973, pp. 14-15.

Edlin, Herbert L. *What Wood is That?* The Viking Press, 625 Madison Avenue, N.Y. 10022.

Fine Hardwoods Selectorama. Fine Hardwoods Association, 666 Lake Shore Drive, Chicago, Illinois.

Forest Products Laboratory List of Publications on the Growth, Structure & Identification of Wood. U.S. Dept. of Agriculture, Forest Service, Forest Products Laboratory, September, 1967, Madison, Wisconsin 53705.

Foss, Maurice F. "Use Slides for Wood Identification." *Industrial Arts and Vocational Education, October, 1968, p33.*

Fuglsby, Glen O. "The Underestimated Quarter." *Industrial Arts and Vocational Education*, March, 1967, p133.

Harrar, E.S. *Hough's Encyclopedia of American Woods, Reference Information Volumes 1-5; Wood Samples Volumes 1-13.* Robert Speller & Sons, N.Y.

How to Specify and Use Hardwoods. Reprinted from *National Hardwood Magazine.*

Harlow, William M. *Inside Wood-Masterpiece of Nature.* The American Forestry Association, 1319 18th N.W.., Washington, DC 20006.

Identification of Furniture Woods, The. U.S. Dept. of Agriculture, Miscellaneous Circular #66, U.S. Government Printing Office, Washington, D.C. 20402.

Kukachka, B. Francis. *Properties of Imported Tropical Woods.* U.S. Department of Agriculture, Forest Service Research Paper FPL125, Forest Products Laboratory, September, 1967, Madison Wisconsin 53705.

Lamb George. *The Mahogany Book*. Mahogany Association, Inc., 75 East Wacker Drive, Chicago, Illinois.

Missouri Trees. Missouri Conservation Commission, Jefferson City, Mo.

Panshin, De Zeeuw & Brown. *Textbook of Wood Technology, Volume 1;* 2nd Edition. McGraw-Hill Book Company, N.Y.

Pastoret, James. *Manual for a Short Course on Properties and Identification of Wood*. School of Forestry, University of Missouri, Columbia, Mo.

Pastoret, James P. "Where does Wood Belong in the Academic Marketplace?" *Wood and Wood Products*, September, 1969, pp. 34-36.

Southern Hardwoods, The. Southern Hardwood Lumber Manufacturers Association, Memphis, Tennessee.

Tiemann. *Wood Technology, Constitution, Properties & Uses*, 3rd Edition. Pitman Publishing Corp., N.Y.

Trees, The Yearbook of Agriculture 1949. U.S. Dept. of Agriculture; U.S. Government Printing Office, Washington, D.C. 20402.

Wood, Colors and Kinds. Agriculture Handbook #101, U.S. Dept of Agriculture, U.S. Government Printing Office, Washington, D.C. 20402.

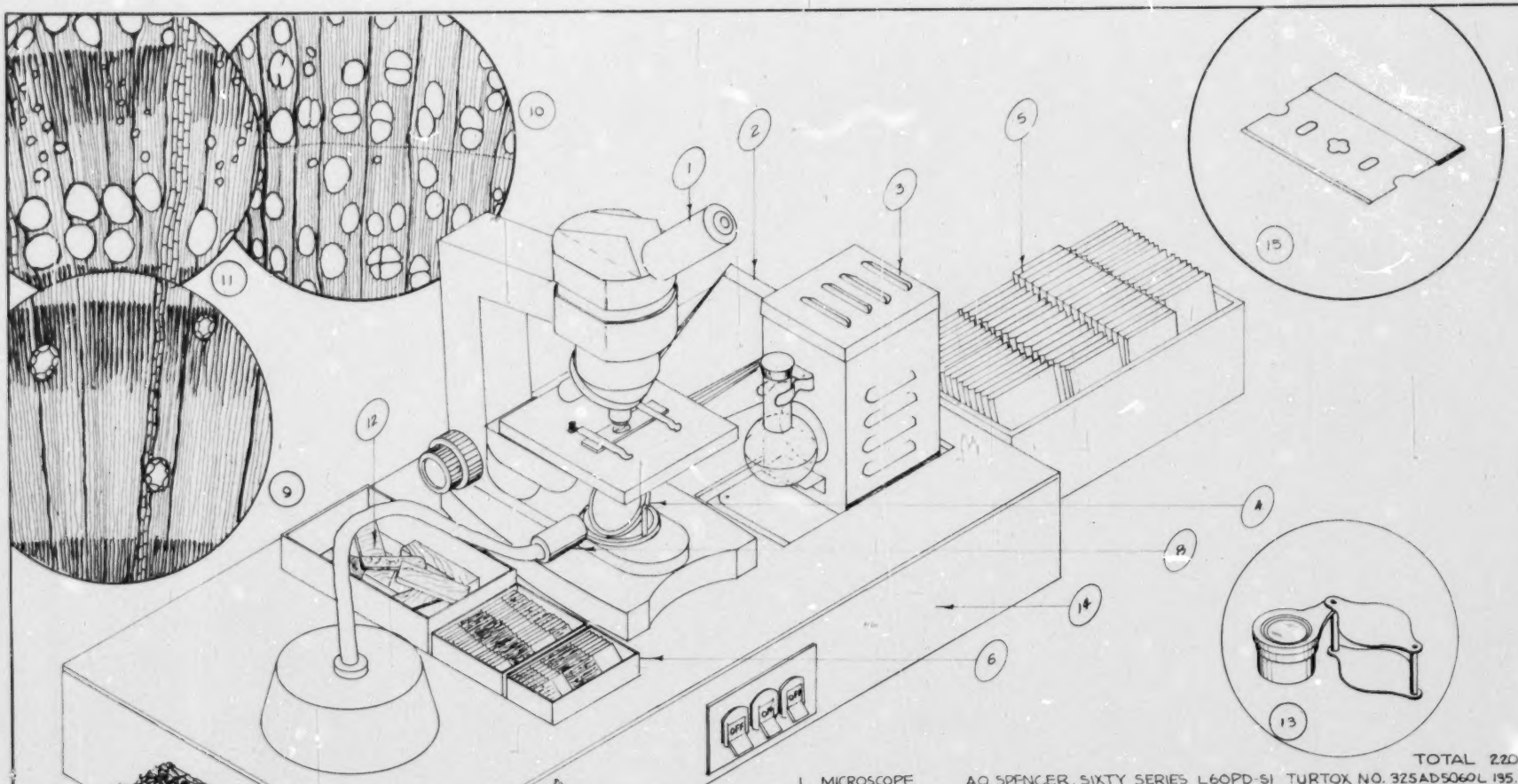
Wood Handbook #72. U.S. Dept. of Agriculture, U.S. Government Printing Office, Washington, D.C. 20402.

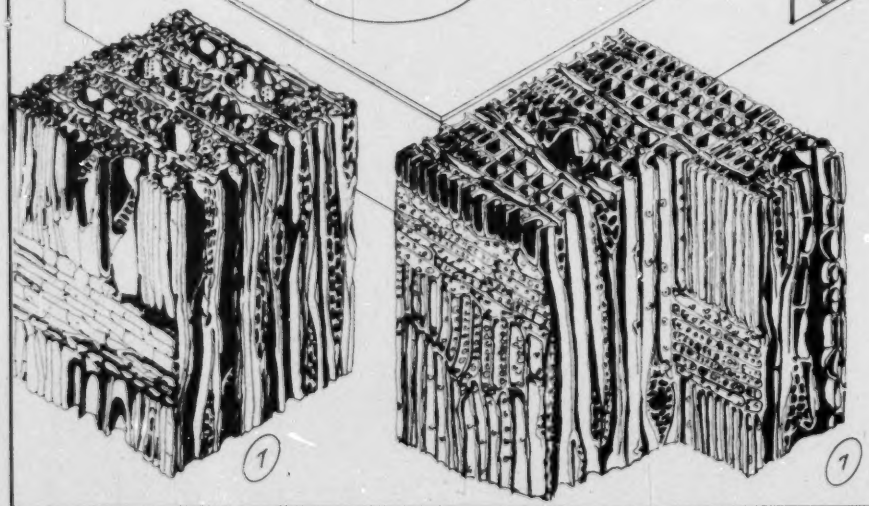
Wood sample sets can be obtained from the following sources:

Frank Paxton Lumber Co., 6311 St. John Ave., Kansas City, Mo. 64123

Craftsman Wood Service Co., 2727 South Mary Street, Chicago, Illinois 60608.

Forest Products Laboratory, Dept. of Fisheries and Forestry, Montreal Road, Ottawa 7, Canada.





		TOTAL	220.15
1. MICROSCOPE	A.O. SPENCER, SIXTY SERIES L60PD-SI	TURTOX NO. 325AD5060L	195.00
2. SCOPE-AID	3" × 3½" SCREEN	TURTOX NO. 330A36	8.95
3. SCOPE-LIGHT	110 VOLT AC, USED WITH SCOPE-AID	TURTOX NO. 330A365	22.75
4. CONCAVE MIRROR	USED WITH SCOPE-AID AND LIGHT	TURTOX NO. 325A50-0L	8.00
5. WOOD SAMPLES	48 SAMPLES ¼" × 2¼" × 5¼"	PAXTON LUMBER CO.	6.50
6. SLIDES	12 SLIDES OF 6 COMMON SPECIES	TURTOX NO. 65	13.00
7. WOOD ANATOMY	2 BLOCKS, 1 SOFT WOOD, 1 HARD WOOD	TURTOX NO. 25D71	3.00
8. SCOPE-LIGHT	110 VOLTS AC, CONCENTRATED LAMP	TURTOX NO. 325A85	18.95
9. ENLARGEMENT	CROSS SECTION OF WHITE PINE, SOFT WOOD, NON POROUS		——
10. ENLARGEMENT	CROSS SECTION OF BIRCH, HARD WOOD, DIFFUSE POROUS		——
11. ENLARGEMENT	CROSS SECTION OF OAK, HARD WOOD, RING POROUS		——
12. SAMPLES	SOLID WOOD SPECIMENS	RANDOM SELECTION	——
13. MAGNIFIER	POCKET MODEL-B, TRIPLET, POWER 10x	TURTOX NO. TN325AA125	3.95
14. PLATFORM	FOR MICROSCOPE, LIGHTS, SAMPLES, AND SCOPE-AID		——
15. BLADE	SINGLE EDGE RAZOR BLADE		.05

WOOD STUDY CENTER
STRUCTURE, PROPERTIES & IDENTIFICATION

SCALE 3/8" = 1"	APPROVED BY:	DRAWN BY: JCD
DATE 1-7-71	O. OATMAN	REVISED

SOUTHWEST MISSOURI STATE COLLEGE
SPRINGFIELD, MISSOURI

DRAWING NUMBER 1 — 1

7-10

AUTOMATIC DRYING CHAMBER

The drying unit (Fig. 4) designed and fabricated for use in drying finishes, curing adhesives, polymerizing methacrylated woods, drying polyethylene glycol treated woods and for research activities in wood drying is an optional piece of equipment. It is possible to work in all the seven areas of the woodworking curriculum without this unit. The drawings, without a procedure or methods study is included in this guide for your information. Level III and IV students can fabricate and construct the dryer for a woodworking industrial arts laboratory. The drying sequence and operating procedure are included to illustrate the advantages of the Automatic Drying Chamber.

Drying Control Sequences

No. 1 Heat and air circulation sequenced by the thermostat
- No. 1 switch on (located on side of chamber)
- No. 2 switch off (located on end of chamber)

No. 2 Heat sequenced by thermostat without air circulation
- No. 1 switch off (located on side of chamber)
- No. 2 switch off (located on end of chamber)

No. 3 Heat sequenced by thermostat with continuous air circulation
- No. 1 switch off (located on side of chamber)
- No. 2 switch on (located on end of chamber)

Operating Instructions:

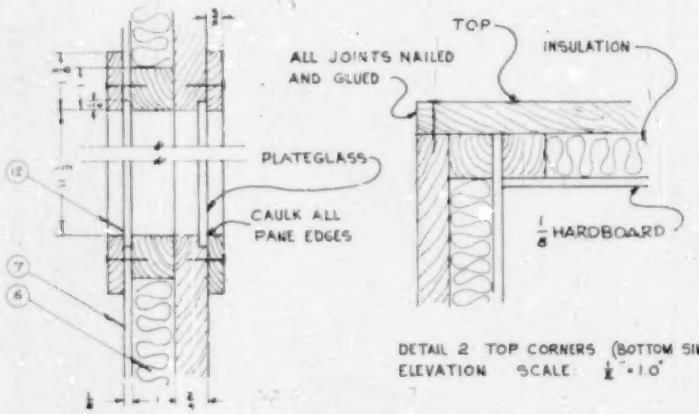
1. Select drying sequence desired, either 1, 2 or 3. No. 1 is most highly recommended.
2. Open or pull safety disconnect switch, located near the fan, to operate drying chamber.
3. Turn timer knob to the time selected for drying by turning knob past the desired time and then moving it back to the selected time. Approximate time lapse required to reach selected heat ranges are timed from 75° to:

90°F	5 Minutes
100°F	10 "
110°F	15 "
120°F	20 "
130°F	30 "
140°F	40 "
150°F	50 "
160°F	60 "
170°F	1 hr. 15 "
180°F	1 hr. 40 "
190°F	2 hr. 20 "
200°F	3 hr. 5 "
210°F	4 hr. 35 "

4. Set the knob of the thermostat to the desired temperature for drying. Average temperature range inside chamber will be approximately 5° lower than the thermostat setting. At elevated heats there is a 10° variance.

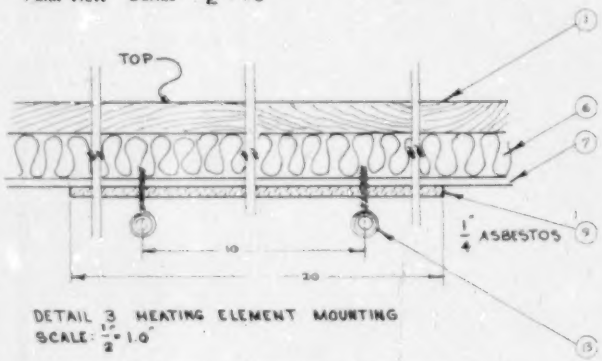
5. If drying time required is more than 12 hours, turn timer dial to the HOLD position, which will allow the drying chamber to operate continuously at the set temperature until switched off. All controls and heat are turned off automatically by timer.

6. Before removing or inspecting the product in the chamber, close or push safety disconnect switch located on the end of the chamber. Open or pull switch after chamber door has been closed to continue drying operation if desired.

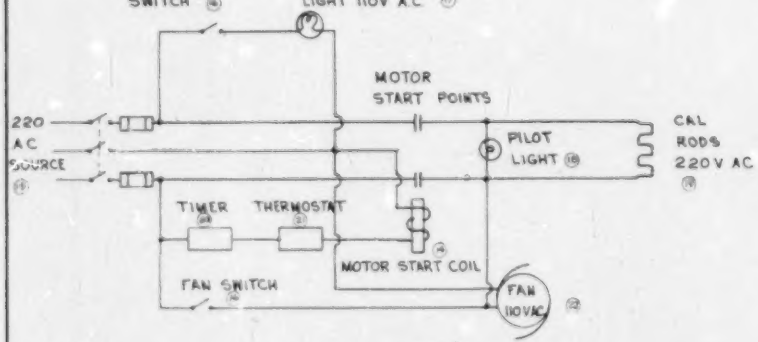


DETAIL 2 TOP CORNERS (BOTTOM SIMILAR)
ELEVATION SCALE 1" = 1.0"

DETAIL 1 WINDOW JAM (HEAD & SILL SIMILAR)
PLAN VIEW SCALE 1" = 1.0"



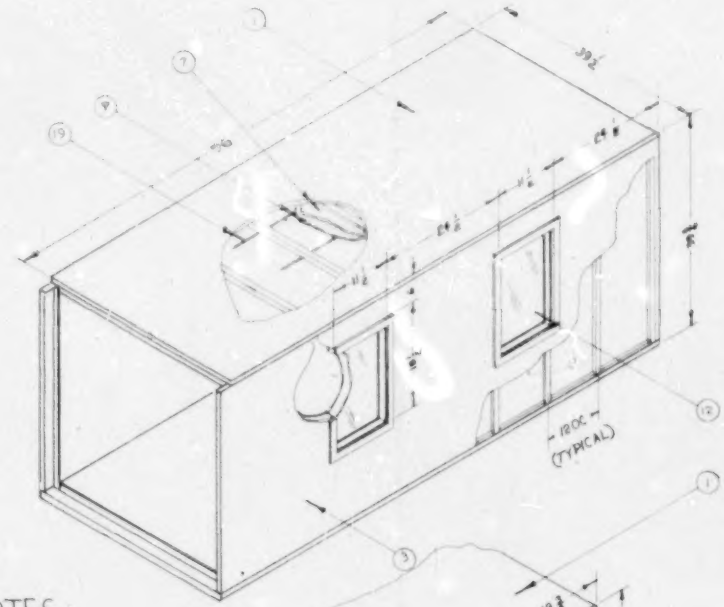
DETAIL 3 HEATING ELEMENT MOUNTING
SCALE: 1/2" = 1.0"

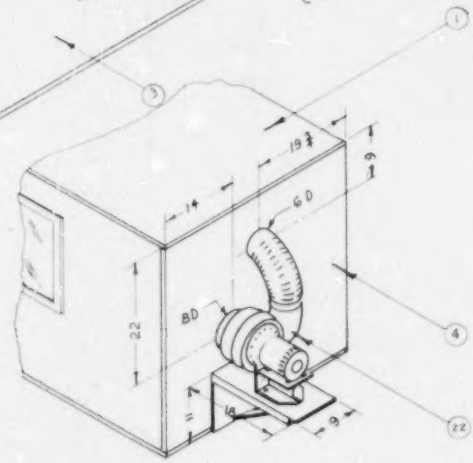


CONTROL SCHEMATIC

GENERAL NOTES

1. NAIL AND GLUE ALL JOINTS ON EXTERIOR AND INTERIOR PANELS.
2. CAULK EDGES OF WINDOW PANES BOTH EXTERIOR AND INTERIOR.
3. CHAMBER MAY BE MOUNTED ON SUITABLE STAND TO FACILITATE EASY ACCESS AND VIEWING.





DETAIL 5 CIRCULATION FAN (CENTRIFUGAL BLOWER SHOWN)
REAR VIEW SCALE 3/4" = 1.0"

AUTOMATIC DRYING CHAMBER			
AS SHOWN			
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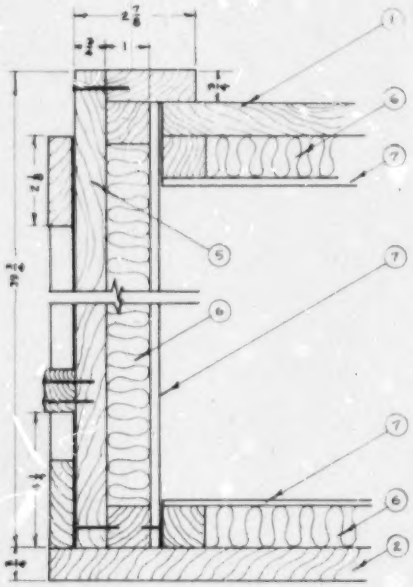
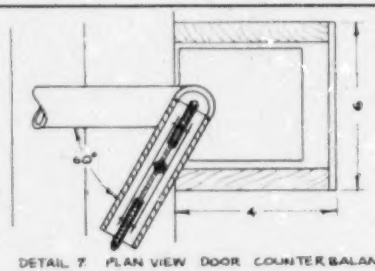
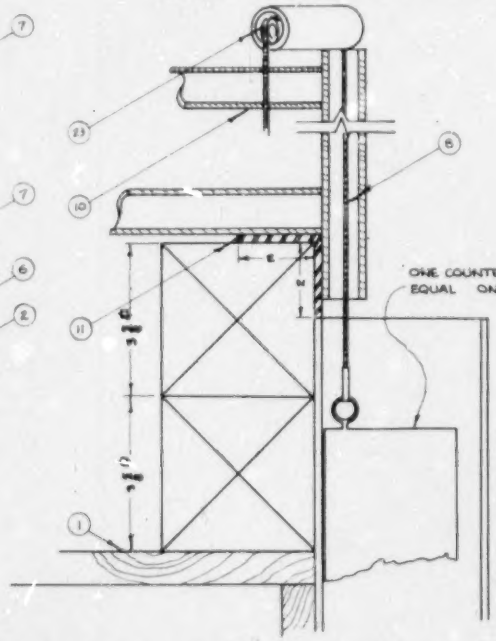
O. CATMAN			
SOUTHWEST MISSOURI STATE INDUSTRIAL EDUCATION			1 OF 2



DETAIL 6. DOOR SECTION A-A
SCALE: 1" = 1.0"

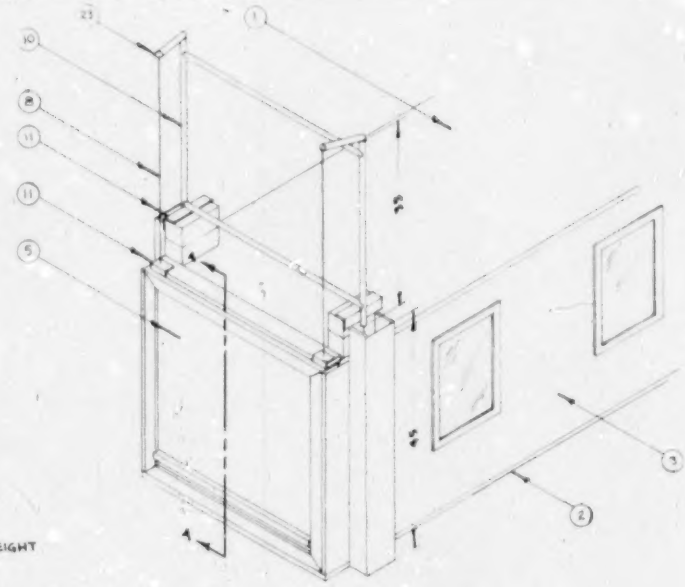


DETAIL 7. PLAN VIEW DOOR COUNTERBALANCE



ONE COUNTER BALANCE TO EQUAL ONE HALF DOOR WEIGHT

DETAIL 8. DOOR COUNTER BALANCE RIGGING
SCALE: 1" = 1.0"



DETAIL 9. DOOR LOCATION ON CHAMBER
SCALE: 3/4" = 1'-0"

NO	NAME	MATERIAL	REQD	ROUGH SIZE	FINISH SIZE	UNIT 100 FT	TOTAL 100 FT	UNIT COST	TOTAL COST
								TOTAL	$538.45
23	DOOR RIGGING	PULLEY	4	3" O.D				.25	1.00
22	FAN	CENTRIFUGAL	1	110 VAC 1/4 HP 1750 RPM					#4.00
21	THERMOSTAT	HONEYWELL #T6356A	1	REMOTE BULB 110 VAC LINE CONTROL					2.025
20	TIMER	M H RHODES #90000	1	12 HOUR 20 AMP 125 VAC					16.00
19	CAL RODS	HEATING ELEMENTS	2	220 VAC, 62" LONG				9.50	19.00
18	PILOT LIGHT	NEON	1	220 VAC, RED, W/ LENZ COVER					1.42
17	INTERIOR LIGHT	INCENDESENT	1	110 VAC OPPOSED SOCKET					2.15
16	SWITCH	SPST	2	110 VAC GENERAL PURPOSE "Y" BOX				3.00	6.00
15	DISCONNECT SWITCH	CUTLER/HAMMER	1	220 VAC NEMA CLASS "1 FUSED					10.00
14	RELAY	HONEYWELL # R8SIE	1	240 VAC CONTACTS 110VAC COIL SPST					16.05
13	INSULATED HANGERS		12					.20	2.40
12	WINDOWS	PLATE GLASS	4		12 x 19			.72	2.88
11	DOOR RIGGING	ANGLE IRON	2	1/4 x 2 x 2 x 24	1/4 x 2 x 2 x 12	44/FT		44/FT	.88
10	DOOR RIGGING	PIPE	19 1/2'		AS NEEDED			.30/FT	4.05
9	INSULATION	ASBESTOS SHEET	1	1/4 x 42 x 48	1/4 x 20 x 72			.80/FT	2.80
8	CABLE	WIRE ROPE	2	8'	AS NEEDED			.50/FT	4.80
7	INNER LINING	HARDBOARD 1/8"	8	4'0" x 8'0"	AS NEEDED			3.84	19.20
6	INSULATION	FIBERGLAS	1		AS NEEDED		100	.175	17.50
5	DOOR	PLYWOOD, INTERIOR, A.D.	1	38 x 40	38 x 39 1/2		10.56		4.11
4	END	PLYWOOD, INTERIOR, A.D.	1	40 x 40	39 1/2 x 39 1/2		11.12		4.34
3	SIDE	PLYWOOD, INTERIOR, A.D.	2	40 x 96	39 1/2 x 96	26.66	53.32	10.40	20.80
2	BOTTOM	PLYWOOD, INTERIOR, A.D.	1	40 x 96	39 1/2 x 96		26.66		10.40
1	TOP	PLYWOOD, INTERIOR, A.D	1	40 x 96	39 1/2 x 99 1/8		26.66		10.40

AUTOMATIC DRYING CHAMBER

SCALE AS SHOWN			
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"O" OATMAN			
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SUGGESTED TEXTBOOKS AND REFERENCES

LEVELS I	II	III	IV	
				SUGGESTED TEXTBOOKS
x				I. Groneman, Chris H. and John Feirer. **General Shop;** Fourth Edition. McGraw-Hill Book Company, St. Louis, Missouri (533pp.), 1969.
	x			II. Feirer, John L. **Woodworking for Industry** and **Woodworking for Industry Workbook.** Charles A. Bennet Company, Incorporated, 809 West Detweiller Drive, Peoria, Illinois 61614 (672 pp.), 1971.
		x		III. Zook, Wayne H. **Constructing and Manufacturing Wood Products.** McKnight Publishing Company, Bloomington, Illinois 61701 (475pp.), 1972.
			x	IV. Feirer, John L. **Cabinetmaking and Millwork** and **Cabinetmaking and Millwork Student Guide.** Charles A. Bennett Company, Incorporated, Peoria, Illinois 61614 (928pp.), 1970.
				REFERENCES
x	x			Anderson, Arthur D. **A Designer's Notebook.** McKnight Publishing Company, Bloomington, Illinois 61701.
	x	x	x	Baker, Glenn E. and L. Dayle Yeager. **Wood Technology.** Howard W. Sams & Co., Inc., 4300 West 62nd St., Indianapolis, Ind. 46268.
x				Bauer, C.E., R.L. Thompson and J.G. Miller. **Comprehensive General Shop Series:** I, II, & III. The Bruce Publishing Company, 866 Third Avenue, New York, New York 10022.
x				Boyd, Gardner T., Willis H. Wagner, Walter C. Brown, and Howard H. Gerrish. **Modern General Shop.** Goodheart-Willcox, 123 West Taft Drive, South Holland, Illinois 60473.
	x	x	x	Bushwell, William. **Painting and Decorating Encyclopedia.** Goodheart-Willcox, South Holland, Illinois.
		x	x	Dahl, J. and Douglas Wilson. **Cabinetmaking and Millwork: Tools, Materials, Layout, Construction,** American Technical Society, 848 East 58th Street, Chicago, Illinois 60637.
	x	x		Douglas, J.H. **Projects in Wood Furniture.** McKnight Publishing Company, Bloomington, Illinois, 1967.
	x	x	x	Feirer, John L. and Gilbert Hutchings. **Advanced Woodwork and Furniture Making.** Charles A. Bennett Company, Inc., Peoria, Illinois, 1972.
x	x			Feirer, John L. **Bench Woodwork.** Charles A. Bennett Company, Inc., Peoria, Illinois, 1972.
x	x			Feirer, John L. **Industrial Arts Woodworking** and **Workbook for Industrial Arts Woodworking.** Charles, A. Bennett Company, Inc., Peoria, Illinois.
x	x			Fryklund, Verne C. and Armand J. LaBerge. **General Shop Woodworking.** McKnight Publishing Company, Bloomington, Illinois, 1972.
x	x			Gerbracht, Carl and Frank E. Robinson. **Understanding America's Industries.** McKnight Publishing Company, Bloomington, Illinois, 1971.
	x	x		Gottshall, Franklin H. **How to Make Colonial Furniture.** The Bruce Publishing Company, New York, New York.
	x	x		Groneman, Chris H. and Everett R. Glazener. **Technical Woodworking.** McGraw-Hill Book Company, CCD-28th Floor, 1221 Avenue of the Americas, New York, New York 10020.

LEVELS				
I	II	III	IV	
	x	x	x	Hackett, Donald and Patrick E. Spielman. **Modern Wood Technology.** The Bruce Publishing Company, New York, New York.
		x	x	Hammond, James J., Edward T. Donelly, Walter F. Harrod and Norman A. Rayner. **Woodworking Technology** and **Study Guide forWoodworking Technology.** McKnight Publishing Company, Bloomington, Illinois, 1972.
x	x			Haws, Robert W. and Carl J. Schaefer. **Manufacturing in the School Shop.** American Technical Society, Chicago, Illinois.
x	x			Holbrook, Wallace W. **Contemporary Lamps.** McKnight Publishing Company, Bloomington, Illinois.
		x	x	Katz, Laszlo. **The Art of Woodworking and Furniture Appreciation.** P.F.C. Woodworking, Inc., 525 West 26 St., New York, N.Y. 10001.
x	x			Klenke, William W. **The Art of Woodturning.** Charles A. Bennett Company, Inc., Peoria, Illinois.
x	x			Lindbeck, John L. **Designing Today's Manufactured Products.** McKnight Publishing Company, Bloomington, Illinois, 1972.
x				Lindbeck, John R. and Irvin T. Lathrop. **General Industry.** Charles A. Bennett Company, Inc., Peoria, Illinois, 1969.
x	x			Lindbeck, John R., Lester G. Duenk and Marc F. Hansen. **Basic Crafts.** Charles A. Bennett Company, Inc., Peoria, Illinois, 1973.
x	x			Matthews, John. **Creative Log Sculpture.** Stanley Tools, New Britain, Connecticut.
	x	x		McDonnell. **The Use of Portable Power Tools.** Delmar Publishers, P.O. Box 5087, Albany, New York 12205.
	x	x	x	McKnight World of Work Curriculum, The. **World of Work, Succeeding in the; Strategies for Implementing Work Experience Programs and Activities for Succeeding in the World of Work.** McKnight Publishing Company, Bloomington, Illinois, 1970.
x				Olson, Delmar W. **Industrial Arts for the General Shop;** Fourth Edition. Prentice-Hall, Englewood Cliffs, New Jersey 07632, 1973.
	x			O'Neill, James. **Early American Furniture.** McKnight Publishing Company. Bloomington, Illinois.
x	x			Piepenburg, Robert E. **Designs in Wood.** The Bruce Publishing Company, New York, New York.
	x	x	x	Rebhorn, Eldon. **Woodturning.** McKnight Publishing Company, Bloomington, Illinois, 1972.
x				Smith, Lavon B. and Marion B. Maddox. **Elements of American Industry.** McKnight Publishing Company, Bloomington, Illinois, 1966.
		x	x	Soderberg, George A. **Finishing Technology.** McKnight Publishing Company, Bloomington, Illinois, 1969.
	x	x		Tierney, William F. **Modern Upholstering Methods.** McKnight Publishing Company, Bloomington, Illinois.

LEVELS				
I	II	III	IV	
	x	x		Wagner, Willis H. **Modern Woodworking.** Goodheart-Willcox, South Holland, Illinois.
x				Wagner, Willis H. **Woodworking.** Goodheart-Willcox, South Holland, Illinois.
		x	x	**Wood Handbook #72.** U.S. Department of Agriculture, U.S. Government Printing Office, Superintendent of Documents, Washington, D.C. 20402.
x	x			Zimmerman, Fred W. **Exploring Woodworking.** Goodheart-Willcox, South Holland, Illinois.

VISUAL AIDS

AVAIL-ABILITY*		LEVELS I	II	III	IV	PROCESS AREA	NO.	SELECTIONS
						[F] FILMS 16MM		
	fl	x	x			General Information	F-1	**ABC of Hand Tools.** Walt Disney, General Motors Corporation, 2 reels, Part I & II, 33 minutes, sound, color.
	fl	x	x	x		Design	F-2	**American Look.** Sandy Company, Bill, 29 minutes, sound, color.
	fl		x	x	x	IV. Production Product of Industry	F-3	**Art of Making Furniture.** Association-Sterling Films, 20 minutes, sound, color.
	fl		x	x	x	V. WPC Process	F-4	**Atomic Revolution in Wood.** United States Atomic Energy Commission, 1969, 23 minutes, sound, color.
	fl		x	x	x	VI. Residential Construction	F-5	**Challenge of the Seventies. To Make a House a Home.** Georgia-Pacific Corporation, 1970, 30 minutes, sound, color.
	fl	x	x	x		General Information	F-6	**Endless Forest, The.** Dierks Forests, Inc., Modern Talking Picture Service, Inc., #3043, 28 minutes, sound, color.
p			x	x	x	I. Wood Lamination & VI. Residential Construction	F-7	**Fire Endurance of Heavy Timber.** National Lumber Manufacturers Association, 15 minutes, sound, color.
p			x	x	x	Career & Employment Opportunities	F-8	**Making it in the World of Work.** McKnight Publishing Company, 25 minutes, sound, color.
	fl			x	x	General Information	F-9	**Mechanism of Moisture Movement in Wood.** University of Missouri, 30 minutes, sound, color.
	fl	x	x	x		General Information	F-10	**Mighty Western Forest, The.** Western Wood Products Association, Modern Talking Picture Service, Inc., #2928, 27 minutes, sound, color.
	fl	x	x	x		III. Wood Flour & Particle Molding	F-11	**Miracle in Wood.** American Plywood Association, Modern Talking Picture Service, Inc., #3159, 27 minutes, sound, color.
	fl		x	x	x	Safety	F-12	**New Approach to Table Saw Guarding Safety with Visibility.** Foredom Electric Company, Brett-Guard Division, 15 minutes, sound, color.
	fl	x	x			General Information	F-13	**New Horizons for Wood.** Dr. William M. Harlow, University of Missouri, 28 minutes, sound, color.
	fl	x	x	x	x	IV. Production Product of Industry & General Information	F-14	**Package and the Product, The.** Danfoods Corporation, Modern Talking Picture Service, Inc., #3102, 14 minutes, sound, color.
	fl	x	x	x		III. Wood Flour & Particle Molding and General Information	F-15	**Paper Forest, The.** Southern Pulpwood Conservation Association, Modern Talking Picture Service, Inc. #2593, 28½ minutes, sound, color.

*p--indicates purchase
*fl--indicates free loan

AVAIL-ABILITY*		LEVELS I	II	III	IV	PROCESS AREA	NO.	SELECTIONS
	fl		x	x	x	VI. Residential Construction	F-16	**Portrait of Stockholm.** The Swedish Institute for Cultural Relations, Modern Talking Picture Service, Inc., #2779, 14 minutes, sound, color.
	fl		x	x	x	Finishing, spray	F-17	**Ransburg Electrostatic Painting.** Ransburg Electro-Coating Corporation, 1965, 22 minutes, sound, color.
	fl		x	x	x	Career & Employment Opportunities	F-18	**Story of Human Enterprise, The.** Georgia-Pacific Corporation, 1970, 28 minutes, sound, color.
	fl		x	x	x	II. PEG Diffusion Process	F-19	**This is Fiber Glass.** PPG Industries, Inc., Modern Talking Picture Service, Inc., #2387, 13½ minutes, sound, color.
	fl	x	x	x		III. Wood Flour & Particle Molding	F-20	**Time of Change.** The American Hardboard Association, Modern Talking Picture Service, Inc., #3303, 13½ minutes, sound, color.
	fl		x	x	x	VI. Residential Construction	F-21	**Unicom Method of House Construction.** National Forest Products Association, sound, color.
	fl		x	x	x	II. PEG Diffusion Process	F-22	**WASA.** The Swedish Institute for Cultural Relations, Modern Talking Picture Service, Inc., #2772, 18 minutes, sound, color.
	fl		x	x	x	I. Wood Lamination & General Information	F-23	**Wood Bending-A New Twist.** Syracuse University, School of Forestry, 13 minutes, sound, color.
	fl	x	x	x		VII. Wood Structure, Properties, & Identification	F-24	**Wood, Masterpieces of Creation.** Syracuse University, School of Forestry, 28 minutes, sound, color.
	fl	x	x	x	x	V. WPC Process	F-25	**Wood Plastic-A New Dimension.** Syracuse University, School of Forestry, 11½ minutes, sound, color.
p			x	x	x	I. Wood Lamination & VI Residential Construction	F-26	**Wood That Could, The.** American Institute of Timber Construction, 1968, 29 minutes, sound, color.
						(T) TRANSPARENCIES		
p			x	x		General Information	T-1	**Advanced Woodwork & Furniture Making.** (transparency masters) Charles A. Bennett Company, Inc.
p			x	x		VI. Residential Construction	T-2	**Building Construction.** DCA Educational Products, Inc., 1970, 24 sheets.
p			x	x	x	VI. Residential Construction	T-3	**Carpentry: Framing I & II, Staircase Construction, Interior and Exterior Trim.** 3M Company, Educational Services, 160 sheets.
p		x	x			General Information	T-4	**General Industry.** Charles A. Bennett Company, Inc.

*p--indicates purchase
*fl--indicates free loan

AVAIL-ABILITY*		LEVELS I	II	III	IV	PROCESS AREA	NO.	SELECTIONS
p		x	x			General Information	T-5	**General Woodworking.** Groneman, Helsel. McGraw-Hill, 8 sheets.
p			x	x	x	VII. Wood Structure, Properties & Identification	T-6	**Wood Structure Series.** James Pastoret, School of Forestry, University of Missouri, 1968, 35 sheets.
p		x	x	x		General Information	T-7	**Wood Technology I.** DCA Educational Products, Inc., 20 sheets.
p			x	x	x	General Information	T-8	**Wood Technology II.** DCA Educational Products, Inc. 24 sheets.
p		x	x	x	x	General Information	T-9	**Safety: Machines & Power Tools.** DCA Educational Products, Inc.
						[S] SLIDES 35MM		
p			x	x	x	VII. Wood Structure, Properties, & Identification	S-1	**Deciduous Trees [Hardwood].**General Biological, Inc., 51 Slides
	fl		x	x	x	All Seven Process Areas	S-2	**Industrial Arts Woodworking Curriculum.** Wood Technology Section, Industrial Education Department, Southwest Mo. State University, Springfield, Mo. 65802, (or your district University), 160 slides, tape 52 minutes &/or 1 hr. 13 minutes, color, 1972.
p		x	x	x		IV. Production Product of Industry	S-3	**Planning Line Production.**NEA Stock #648-21306, American Industrial Arts Association, 103 slides, 30 minute tape, color.
p			x	x	x	IV. Production Product of Industry	S-4	**Study of the Furniture Industry,** A. Norman Zaniboni, American Industrial Arts Association, 160 slides, 50 minutes, tape, color.
p			x	x	x	VII. Wood Structure, Properties, & Identification	S-5	**Trees [Gymnosperms]** General Biological, Inc., 20 slides.
	fl		x	x	x	VI Residential Construction	S-6	**Versatile Timber Construction.** American Institute of Timber Construction, 105 slides, script, color.

*p--indicates purchase
*fl--indicates free loan

AVAIL-ABILITY*		LEVELS I	II	III	IV	PROCESS AREA	NO.	SELECTIONS
						[FS] FILMSTRIPS 35 MM		
p		x	x	x		General Information	FS-1	**Design in Wood.** McGraw-Hill Book Company.
p		x	x			General Information	FS-2	**Hardwood Lumbering.** McGraw-Hill Book Company.
p		x	x			General Information	FS-3	**Hardwood Processing.** McGraw-Hill Book Company.
p		x	x			IV. Production Product of Industry	FS-4	**Industry in 20th Century America.** Charles A. Bennett Company, 5 strips 3 records.
p		x	x			General Information	FS-5	**Safety in the Shop.** McGraw-Hill Book Company.
	fl		x	x		General Information	FS-6	**Story of Coated Abrasives The.** Coated Abrasives Manufacturing Institute. Society for Visual Education, Inc.
p			x	x	x	General Information & Employment & Career Opportunities	FS-7	**Trees for 2001:* Todays Foresters in Action.** (Filmstrips or slides) Guidance Associates, American Forest Institute 116 frames, 17 minutes, record or cassette, color
p		x	x			General Information	FS-8	**Wood Finishing Part I & Part II.** McGraw-Hill Book Company.
p		x	x	x	x	General Information	F.T. and FS	Selected Assortment in the Areas of: **Safety, Drafting & Design, Measuring Tools, Hand Tools, Portable Power Tools, Stationary Power Tools, Manipulative Production Skills, Career and Employment Opportunities.** Brodhead-Garett Company, 1973, 16MM, 8MM, Super 8MM, Super 8 closed loops, transparencies, charts, and film strips.

*p--indicates purchase
*fl--indicates free loan

SOURCES OF VISUAL AIDS

Addresses of sources for visual aids are listed below. It is suggested that teachers obtain new listings from these and other sources to keep their program up to date with technological advances in areas of wood technology.

It would be impractical to list in this guide all of the visual aids and the distributor's addresses that are available. However, several have been selected for each of the process areas, for general information, career and employment opportunities.

Two references have been listed to aid you in selecting additional visual aids:

Educators Guide to Free Films. Educators Progress Service, Inc., Randolph, Wisconsin 53956.

Index to Vocational and Technical Education (Multimedia); 1st Edition. National Information Center for Educational Media (Micem), University of California, University Park, Los Angeles, California 90007, 1972.

Aims Instructional Media Services, Inc., P.O. Box 1010, Hollywood, California 90028.

American Forest Institute, 1619 Massachusetts Avenue, N.W. Washington D.C 20036.

American Industrial Arts Association, 1201 Sixteenth Street, N.W. Washington, D.C. 20036.

American Institute of Timber Construction, 1700 K. Street, N.W. Washington, D.C. 20006.

Association-Sterling Films, 512 Burlington Avenue, La Grange, Illinois 60525.

AV Instructional Systems, P.O. Box 191, Somers, Connecticut 06071.

BFA Educational Media, 2211 Michigan Avenue, Santa Monica, California 90404.

Brett-Guard Division, Foredom Electric Company, Route 6, Bethel, Connecticut 06801.

Brodhead-Garrett Company, 4560 East 71st Street, Cleveland, Ohio 44105.

Charles A. Bennett Company, Inc., 809 West Detweiller Drive, Peoria, Illinois 61614.

DCA Educational Products, Inc., 4865 Slenton Avenue, Philadelphia, Pennsylvania 19144.

General Biological, Inc., 8200 South Hoyne Avenue, Chicago, Illinois 60620.

General Motors Corporation, Public Relations Staff, Film Library, General Motors Building. Detroit, Michigan 48202.

Georgia-Pacific Corporation, Education Film Library, 900 S.W. Fifth Avenue, Portland, Oregon 97204.

Hoover's, 1511 Baltimore, Kansas City, Missouri 64108.

International Film Bureau, Inc., 332 South Michigan Avenue, Chicago, Illinois 60604.

McGraw-Hill Text Films, 330 W. 42nd Street, New York 10036.

McKnight Publishing Company, Bloomington, Illinois 61701.

Modern Talking Picture Service, Inc., 3718 Broadway, Kansas City, Missouri 64111; or 201 South Jefferson Avenue, St. Louis, Missouri 63103.

National Forest Products Association, 1619 Massachusetts Avenue, N.W. Washington, D.C. 20036.

National Lumber Manufactures Association, 1619 Massachusetts Avenue, N.W. Washington, D.C. 20036.

Ransburg Electro-Coating Corp., Mrs. Ruth A Hussong, 3939 West 56th Street, Indianapolis, Indiana 46208.

RMI Educational Films, Inc., 4916 Main Street, Kansas City, Missouri 64112.

Sandy Company, Bill, Film Distribution Department, 2843 East Grand Boulevard, Detroit, Michigan 48211.

Society for Visual Education, Inc., Division: The Singer Company, 1345 Diversey Parkway, Chicago, Illinois 60614.

Southern Pine Association, Box 1170, New Orleans, Louisiana.

3M Company, Educational Service, Box 3100, St. Paul, Minnesota 55101.

United States Atomic Energy Commission, 9800 South Cass. Avenue, Argonne, Illinois 60439.

United States Forest Service, 710 North 6th Street, Milwaukee, Wisconsin 53203.

University of Missouri, Audiovisual and Communications Services, 119 Whitten Hall, Columbia, Missouri 65201.

West Coast Lumberman's Association, 1410 S.W. Morrison Street, Portland 5, Oregon.

Western Pine Association, 510 Yeon Building, Portland 4, Oregon.

INSTRUCTIONAL RESOURCE MATERIALS & LITERATURE

INTRODUCTION

Instructional resource materials are an important phase of any educational program but they are especally important when the area of study is as broad and complex as modern industry. Industrial arts teachers are fortunate that an almost inexhaustible supply of free and inexpensive literature is available from business and industries throughout the country, as well as governmental agencies.

A sample listing of the type of materials available is included in this compilation. The sources listed are representative of the thousands of companies supplying materials and should provide the industrial arts teachers with a small sampling of available materials. Other sources will be found in professional, education, industrial, business and governmental publication and library indexes.

The following lists are by no means complete; however, many of the materials will reflect ideas relating to new industrial materials and processes, while others will serve to reinforce and supplement contemporary industrial organization and production methods.

HOW TO ORDER MATERIALS

When ordering, give exact title or description of the item desired, print your name and full address and include payment when there is a charge for the material. Indiscriminate requests for "everything you have" should be avoided. It is permissible, however, to request a list of publications or to describe a teaching assignment and request appropriate materials. Orders for materials should be made on school or organizational stationery.

PERIODICALS

American Builder. Simmons-Boradman Publishing Company, Bristol, Connecticut 06012. $3.00 per year submitted to Subscription Department, American Builder. Emmet Street, Bristol, Connecticut 06012.

American Forest. The American Forestry Association, 1319 Eighteenth Street, N.W., Washington, D.C. 20036. $7.50 yr.

Conservationist, The. Missouri Department of Conservation, 2901 North 10 Mile Drive, Jefferson City, Missouri 65101.

Forests and People. Louisiana Forestry Association, P.O. Box 5067, Alexandria, Lousianna 41301.

Forest Industries. Miller Freeman Publishing, Inc., 500 Howard Street, San Francisco, California 94105. $12.50 yr.

Forest Products Journal. Forest Products Research Society, 2801 Marshall Court, Madison, Wisconsin 53705. $25.00 yr.

Furniture Design and Manufacturing. Graphic Arts Publishing Company, 7373 N.Lincoln Avenue, Chicago, Illinois 60646.

Furniture Production. Production Publishing Company, 804 Church Street, Nashville 3, Tennessee. $3.00 yr.

Industrial Education. Macmillan Professional Magazines, Inc., 22 West Pitman Avenue, Greenwich, Connecticut 06830. $7.00 yr.

Journal of Forestry. Society of American Foresters, 1010 16th Street, N.W., Washington, D.C. 20036. $18.00 yr.

Man / Society / Tecnology, A Journal of Industrial Arts Education. 1201 16th Street, N.W., Washington, D.C. 20036. $15.00 annually.

Popular Mechanics. Hearst Corporation, 57th Street at 8th Avenue, New York, New York 10019. $4.00 per year, submit to Popular Mechanics, Box 646, New York, New York 10019.

Popular Science. Popular Science Publishing Company, 353 Fourth Avenue, New York 10, New York. $3.40 per year submitted to Subscription Department.

Product Engineering. McGraw-Hill Publishing Company, 330 West 42nd Street, New York 36, New York. $3.00 per year, published weekly.

School Shop. 416 Longshore Drive, Ann Arbor, Michigan 48107. $8.00 per year. Free when requested on school letterhead stationery.

Wood and Wood Products. Vance Publishing Corp., 300 West Adams Street, Chicago, Illinois 60606. $5.00 yr.

Wood Construction and Building Material List. Wood Construction Publishing Company, 28-30 Kinsey Road, Xenia, Ohio 45385. $2.00 yr.

Woodworking Digest. Hitchcock Publishing Co., Hitchcock Building, Wheaton, Illinois 60187. $15.00 yr.

Wood Preserving. American Wood Preservers Institute, 1651 Old Meadow Road, N.W., Washington, D.C. 20037. $3.60 yr.

OTHER RESOURCE MATERIALS

American Forest Institute, 1835 K Street, N.W., Washington, D.C. 20006. *Forests and Trees of the United States, Growth of a Tree, It's a Tree Country, Products of the Tree Farm, The Story of Insulation Board, The Story of Lumber, The Story of Particleboard* and *The Story of Pulp and paper*.

American Forests Products Industries, Inc., 1816 N. Street, N.W., Washington, D.C. 20036. *The Story of the Hardwood Plywood, Products of the Tree Farm, Growth of a Tree Forests and Trees of U.S., It's a Tree Country, The Story of Lumber, The Story of Hardboard* and *Why We Must Have Tree Farming*.

American Hardboard Association, 20 N. Wacker Drive, Chicago, Illinois 60606. *The Story of Hardboard* and *The Wonderful World of Hardboard*.

American Plywood Association, 1119 A Street, Tacoma, Washington 98401. *Guide to Plywood Grades*.

American Walnut Manufacturer's Association, 666 Lake Shore Drive, Chicago, Illinois 60611. *The Many Faces and Moods of Walnut, American Walnut--The Aristocrat of Fine Cabinet Wood, Growing Walnut for Profit and Pleasure* and *Walnut Veneer Types*.

American Paper Institute, 260 Madison Avenue, New York, New York 10016. *How Paper Came to America, How You Can Make Paper, Of Paper and Opportunity* and *Paper Industry-Fact Sheet*.

Appalachian Hardwood Manufacturers, Inc., 414 Walnut Street, Cincinnati, Ohio 45202. *The Story of Appalachian Hardwoods.*

Borden Chemical Company, The, Division of the Borden Company, 350 Madison Avenue, New York, New York 10017. *Elmer's Wood-gluing Handbook* and *Working with Elmer's Epoxies.*

California Redwood Association, 617 Montgomery Street, San Francisco, California 94111. *Our Growing Redwoods, The Story of the Redwood Forest, Story of the Redwood Lumber Industry, Gluing of Redwood, Strength of Redwood* and *Properties and Uses of California Redwood.*

Clover Manufacturing Company, Norwal, Connecticut. *Swatch Book* and *Coated Abrasive Book.*

DeVilbiss Company, The, 268 Philipi Avenue, Toledo, Ohio 43601. *Spray Gun Motion Study, The ABC's of Spray Equipment,* and *Making the Most of the Spray Painting Method.*

DuPont Series, Automation and Employment, E.I. DuPont de Nemours and Company, Wilmington, Delaware. *The Story of Technology, Man and His Work* and others.

Fine Hardwoods Association, 666 Lake Shore Drive, Chicago, Illinois 60611. *Fine Furniture, Fine Hardwoods Selectorama* and *A World of Fine Hardwoods.*

Ford Motor Company, Educational Affairs Department, The American Road, Dearborn, Michigan. *A History of Measurement* and *The Evolution of Mass Production.*

Franklin Glue Company, Industrial Adhesives, 2020 Buick Street, Columbus, Ohio 43207. *Franklin Tips for Selecting the Right Adhesives.*

Hardwood Plywood Manufacturers' Association, 2310 S. Walter Reed Drive, Arlington, Virginia 22206. *Design Procedure for the Sound Absorption of Resonant Plywood Panels, Veneer* and *Versatile Hardwood Plywood.*

Industrial Forestry Association, 1410 S.W. Morrison Street, Portland Oregon. *West Coast Tree Farms Growing Trees for You* and *Douglas Forestry--Then and Now.*

Irwin Auger Bit Company, The, Wilmington, Ohio 45177. *How to Know the Size of a Bit* and *How to Select, Use and Care for Wood Bits.*

Johnson Wax, Consumer Education Department, FI, Racine, Wisconsin 53403. *Furniture Finishing Methods and Finish Care* and *Handy Hints--First Aid for Furniture.*

Mahogany Association, Incorporated, 666 North Lake Short Drive, Chicago, Illinois 60611. *What Everyone Should Know About Genuine Mahogany.*

National Forest Products Association, 1619 Massachusetts Avenue, Washington D.C. 20036. *Opportunities Unlimited for Careers of Prestige and Profit in the Forest Products Industries.*

National Oak Flooring Manufacturers' Association, 814 Sterick Building, Memphis, Tennessee 38103. *Architects' Specification Manual* and *Oak Floors for Your Home.*

Southern Hardwood Lumber Manufacturing Association, 805 Sterick Building, Memphis, Tennessee 38103. *A Guide to the Physical and Working Characteristics of Southern Hardwoods.*

Southern Pine Association, P.O. Box 52468, New Orleans, Louisiana 70150. *The Southern Pine Story* and *Ten Lessons in Forestry.*

Stanley Tools Division Stanley Works, 600 Myrtle Street, New Britain, Connecticut 06050. *Steel Square.*

State University College of Forestry, Syracuse University, Syracuse, New York 13210. *The Story of Your Christmas Tree, Tree Pest Leaflet Series* and *When You Are in the Woods.*

U.S. Department of Agriculture, Forest Service, Washington, D.C. 20402. *Conservation Activities for Young People, Forest Insects and Diseases, Forests and Wildlife, Making Paper From Trees.*

U.S. Forest Products Laboratory, Information Services, Madison, Wisconsin 53705. *Dividends from Wood Research.*

United States Plywood Corporation, 2305 Superior Avenue, Kalamazoo, Michigan 49003. *Adhesives.*

West Coast Lumber Inspection Bureau, 1410 S.W. Morrison Street, Portland, Oregon 97205. *Grading Ruler.*

Western Red Cedar Lumber Association, 4403 White-Henry-Stuart, Seattle, Washington. *Nails and Nailing.*

Western Wood Products Association, Yeon Boulevard, Portland, Oregon 97204. *Information About our Forests and Products.*

Weyerhaeuser Company, Box A-76, Tacoma Building, Tacoma, Washington 98401. *Let's Learn About the Forest, Forest Packet, Teacher Packet, Treasure of the Timberlands* and *The Weyerhaeuser High Yield Forest.*

Worden and Company, Incorporated, 1827 Jefferson Place, N.W., Washington, D.C. 20036. *How to Paint Your Wood Home.*

Selected Sources for Occupational Information

The agencies and associations listed will provide, upon request, information about occupations and professions specifically related to their fields.

WOODS/CONSTRUCTION

American Federation of Labor, Congress of Industrial Organizations, Building and Construction Trades Dept., 815 16th St., N.W., Washington, D.C. 20006.

American Institute of Interior Designers, 673 Fifth Ave., New York, N.Y. 10022.

Archeology Institute of America, 100 Washington Square East, New York, N.Y. 10003.

Associated General Contractors of America, Inc., 1957 E. St., N.W., Washington, D.C. 20006.

Botanical Society of America, Dept. of Botany, Indiana University, Bloomington, Ind. 47405.

Brotherhood of Painters, Decorators and Paperhangers of America, 217-219 N. Sixth St., Lafayette, Inc. 47091.

National Association of Home Builders, 1625 L St., N.W., Washington, D.C. 20036.

National Association of Plumbing, Heating-Cooling Contractors,1016 20th St., N.W., Washington, D.C. 20036.

National Association of Real Estate Boards, Department of Education, 36 S. Wabash Ave., Chicago, Ill. 60603.

National Paint, Varnish and Lacquer Association, 1500 Rhode Island Ave., N.W., Washington, D.C. 20005.

National Roofing Contractors Association, 300 W. Washington St., Chicago, Ill. 60606.

Society of American Foresters, 1010 16th St., N.W., Washington, D.C. 20006.

Structural Clay Products Institute, 1520 18th St., N.W., Washington, D.C. 20036

EQUIPMENT AND FURNITURE LIST

HAND TOOLS	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Awl, Brad	X	X	2
Awl, Scratch (6")	X	X	4
Bar, Wrecking forged steel, hex stock; ¾"x24"L	X	X	1
Bellows, Molder's (8")	X	X	2
Bit, Auger (set) sizes 4-16	X	X	2
Bit, Combination drill and countersink (set) numbers 1-5	X	X	1
Bit, Combination drill and counterbore (set)	X	X	1
Bit, Electrician's 18"L x 5/16"D	X	X	1
Bit, Expansive boring size 7/8" to 3"	X	X	1
Bit, Extension (18")	X	X	1
Bit, Forstner (brace set) sizes 6, 8, 10, 12, 14, 16 by 16ths of an inch	X	X	1
Bit, Forstner (machine set) ½" shank; sizes 6, 8, 10, 12, 14, 16 in 16ths of an inch	X	X	1
Bit, Multi-spur (set) set of 11; sizes ½"-1" by 16ths; plus 1 1/8" and 1¼"	X	X	1
Bit, Plug cutter (set) set of 5; sizes 3/8" ½", 5/8", ¾", 1"	X	X	1
Bit, Screwdriver (set)	X	X	1
Bit, Twist, Electrician's 3/8" x 18" with square tang	X	X	1
Block, Sanding rubber, to use 2¾ x 9" paper	X	X	24
Brace, Ratchet (10")	X	X	3
Bracket, Saw horse (pair) steel; 12" x 4" lumber	X	X	2

Hand Tools (cont.)	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Broom Push 18" in length	X	X	6
Brush, Bench	X	X	24
Burnisher round tempered steel; 4½" blade	X	X	1
Caliper, Inside (6") solid nut	X	X	2
Caliper, Inside (8") solidnut	X	X	2
Caliper, Outside (6") solid nut	X	X	2
Caliper, Outside (8") solid nut	X	X	2
Can, Oily waste 10 gallon capacity	X	X	1
Can, Safety (1 qt.)	X	X	4
Can, Safety (1 gal.)	X	X	3
Chisel, Butt (set) 3" blade; sizes ¼", ½", ¾", 1", 1½"	X	X	12
Chisel, Carving (set) set of 6 chisels and gauges; approx. 6" long	X	X	4
Chisel, Gouge, Inside (set) sizes ¼", 3/8", ½", ¾", 1"	X	X	3
Chisel, Gouge, Outside (set) set of 5; sizes ¼", 3/8", ½", ¾", 1"	X	X	3
Chisel, Socket firmer (set) set of 6; sizes ¼", 3/8, ½", 5/8", ¾", 1"	X	X	4
Chisel, Wood turning (set) overall length at least 17"	X	X	3
Circle Cutter cap. 1" to 8" diameter	X	X	1
Clamp, Bar (36")	X	X	6
Clamp, Bar (48")	X	X	6
Clamp, Bar (60")		X	2
Clamp, "C" (3")	X	X	4
Clamp, "C" (4")	X	X	4

EQUIPMENT AND FURNITURE LIST

HAND TOOLS	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Clamp, "C" (6")	X	X	4
Clamp, "C" (8")	X	X	4
Clamp, Corner 3" capacity	X	X	4
Clamp, Fixture (set) for use with ¾" pipe	X	X	6
Clamp, Handscrew (no. 3/0)	X	X	6
Clamp, Handscrew (no.0)	X	X	6
Clamp, Handscrew (no. 1)	X	X	12
Clamp, Handscrew (no. 2)	X	X	12
Clamp, Handscrew (no. 3)	X	X	6
Clamp, Mitre frame	X	X	1
Clamp, Spring (no. 2)	X	X	12
Compass, Pencil	X	X	3
Countersink Bit (for brace) (set) size 5/8" and 3/4"	X	X	2
Countersink, High Speed ¼" shank, ½" size	X	X	2
Cutter, Glass	X	X	1
Die, Letter (set) 3/16" character height	X	X	1
Die, Number (set) 3/16" character height	X	X	1
Divider, Wing (6" steel)	X	X	2
Dowel Centers (pairs) (set) ¼", 5/16", 3/8", ½"	X	X	1
Dresser, Abrasive wheel	X	X	1
Drill, Hand (¼")	X	X	4
Drill, Hand (3/8")	X	X	1
Drill Stand (fractional) for twist drills from 1/16" to 1/2" by 64ths	X	X	1

Hand Tools [cont.]	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Drill, Twist, Straight shank (fractional set) high speed, number 2 Morse Taper Shank; 5/8"-1" by 8ths	X	X	1
Files (assorted sizes, shapes, and cuts, with handles, as specified)			
Length — Name or Shape — Cut			
8" Flat — Bastard Double-Cut	X	X	2
10" Flat — Bastard Double-Cut	X	X	2
6" Half-round — Bastard	X	X	2
8" Half-round — Bastard	X	X	2
10" Half-round — Bastard	X	X	2
8" Half-round — Second-Cut	X	X	2
10" Half-round — Second-Cut	X	X	2
8" Mill — Second-Cut	X	X	2
10" Mill — Second-Cut	X	X	2
8" Rat-tail (Round, Slim) — Second-Cut	X	X	2
8" Round — Second-Cut	X	X	2
10" Round — Second-Cut	X	X	2
6" Slim, Taper — Single-Cut	X	X	2
8" Square — Second-Cut	X	X	2
8" Square — Smooth	X	X	2
10" Vixen (Half-round)	X	X	2
8" Wood (Flat) — Coarse	X	X	2
10" Wood (Flat) — Coarse	X	X	2
8" Cabinet (Half-round)	X	X	2
10" Cabinet (Half-round)	X	X	2
10" Cabinet Rasp (Half-round) — Bastard	X	X	2
10" Cabinet Rasp (Half-round) — Bastard	X	X	2
6" Slim, Taper — Single-Cut	X	X	2
File, Auger bit (7")	X	X	3
File Card and Brush 9½" L, brush 1½" x 5"	X	X	6
Funnel	X	X	2
Guage, Auger bit guaging hole depth	X	X	1
Guage, Drill, Fractions	X	X	1

EQUIPMENT AND FURNITURE LIST

HAND TOOLS	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Guage, Marking	X	X	6
Guage, Marking (double bar)	X	X	2
Guage, Screw pitch with 22 pitches from 9 to 40	X	X	1
Guage, Wire and sheet metal (American) sizes 0-36	X	X	1
Guage, Wire and Sheet metal (U.S.S.) sizes 0-36	X	X	1
Gloves, Leather (pair)	X	X	4
Goggles, Clear observation	X	X	24
Grease Gun	X	X	1
Hammer, Claw (7 oz.)	X	X	3
Hammer, Claw (13 oz.)	X	X	3
Hammer, Claw (16 oz.)	X	X	3
Hammer, Magnetic standard upholstered	X	X	2
Hammer, Soft face (4 oz.)	X	X	2
Hose, Air 25' x 14"; heavy duty	X	X	1
Jig, Dowelling with guides 3/16", 1/4" 5/16", 3/8", 7/16", 1/2"	X	X	2
Knife, Putty approx. 1" W; flexible tool steel blade	X	X	3
Knife, Sloyd blade approx. 2 5/8" L	X	X	6
Level (24" long)	X	X	1
Mallet, Hardwood	X	X	4
Mallet, Rawhide (10 oz.)	X	X	4
Miter Box 26" x 4" back saw; 8¼ right angle cap.	X	X	1

Hand Tools [cont.]	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Nail Set (1/16" tip)	X	X	4
Nail Set(3/32" tip)	X	X	4
Nipper, End Cutting (6")	X	X	1
Nozzle, Blow gun (air line)	X	X	1
Oiler, Bench ⅓" or ½" pt. size, 5" straight spout	X	X	6
Oiler, Pump 5 oz. capacity	X	X	1
Oilstone, Carving tool slips (set)	X	X	1
Oilstone, Combination, India course and fine grit; 8" x 1" x 2"	X	X	1
Oilstone, Combination Silicon carbide coarse, fine; 8" x 1" x 2"	X	X	1
Oilstone, Gouge slip	X	X	1
Pan, Dust (12" steel)	X	X	1
Plane, Block 1 5/8" cutter	X	X	3
Plane Iron, Double	X	X	24
Plane, Jack (14" L)	X	X	8
Plane, Rabbet 4"L; 1" cutter	X	X	4
Plane, Router with 3 cutters (¼", ½" and V)	X	X	4
Plane, Smoothing length: 9" blade width: 1¾"	X	X	6
Pliers, Combination (6")	X	X	2
Pliers, Combination (8")	X	X	2
Pliers, Diagonal-cutting (6")	X	X	2
Piiers, End-cutting	X	X	2

EQUIPMENT AND FURNITURE LIST

HAND TOOLS	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Pliers, Vise-grip wrench (7")	X	X	2
Protractor, machinist's bevel 12" blade	X	X	2
Punch, Center (set) set of 5: 1/16"-1/4"	X	X	3
Rule, Flexible Steel tape (6')	X	X	4
Rule, Flexible Steel tape (10')	X	X	4
Rule, Flexible, Steel tape (50')		X	1
Rule, Steel (12")	X	X	8
Rule, Steel (24")	X	X	6
Rule, Steel (36")	X	X	3
Sanding Drums (set)	X	X	2
Saw, Back (12")	X	X	6
Saw, Coping 6½" L, pin-end	X		6
Saw, hack (hand) adjustable to receive 9-12" blade	X	X	1
Saw, Hand, Crosscut 22"-10 point	X	X	4
Saw, Hand, Rip 26"-5½ point, straight back	X	X	1
Saw, Jeweler's (4")	X	X	1
Saw, Keyhole 10" taper; round blade	X	X	1
Saw, Veneer		X	4
Scale, Architect's graduation 3/32", 1/8" 3/16", 1/4", 3/8", 1/2" 3/4", 1", 1½", 3", each equalling 1"-0"	X	X	1
Scissors (8")	X	X	4

Hand Tools [cont.]	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Scraper, Cabinet 2¾" blade	X	X	4
Scraper, Hand approx. 3" x 5" steel blade	X	X	6
Screwdriver, Cabinet tip (4" and 6")	X	X	2
Screwdriver, Offset Phillips (set)	X	X	1
Screwdriver, Offset ratchet	X	X	1
Screwdriver, Offset Straight slot (set) set of tips of 3/16" 9/32" and 11/32"	X	X	2
Screwdriver, Phillips (set) set of points numbers 1, 2, 3	X	X	2
Screwdriver, Spiral ratchet	X	X	2
Screwdriver, Standard bit (round blade) (set) blades 3/16", 1/4", 5/16", 3/8", 1/2"	X	X	2
Screwdriver, Standard bit ('stubby') square shank	X	X	2
Shield, Face	X	X	12
Soldering Copper, Electric (60W) ¼" copper tip with stand	X	X	1
Snips, Tinner's, Straight (no. 8)	X	X	2
Spokeshave, Convex bottom	X	X	4
Spokeshave, Straight	X	X	4
Spray Gun Outfit	X	X	1
Square, Combination(12")	X	X	12
Square, Combination (set) (with protractor and center head) 12"	X	X	1
Square, Steel framing 12" x 24"	X	X	6
Square, Try (6")	X	X	12
Square, Try (12")	X	X	4

EQUIPMENT AND FURNITURE LIST

HAND TOOLS	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Stapler, hand 8½"; throat depth 4"	X	X	1
Stool, Student's adjustable 14" seat with back	X	X	6
Stop, Bench	X	X	6
Tap and Die, NC (U. S. standard) ¼-20, 5/16-18, 3/8-16, 7/16-14, ½-13, complete with die stock and tap wrench	X	X	1
Tap and Die, NF (S.A.E.) (set) ¼-28, 5/16-24, 3/8-24, 7/16-20, ½-20, complete with die stock and tap wrench		X	1
T Bevel (6")	X	X	2
Trammel Points	X	X	2
Triangle, 30 degrees-60 degrees (8")	X	X	1
Triangle, 45 degrees (8")	X	X	1
T Square minimum size 24"	X	X	1
Vise, Bench Drill 3" opening	X	X	1
Vise, Machinist's bench swivel base, 3" jaw, 4¾" opening	X	X	2
Vise, Miter	X	X	1
Vise, Swivel 2" jaw, rapid positioning	X	X	1
Wrench, Adjustable end (6")	X	X	2
Wrench, Adjustable end (8")	X	X	1
Wrench, Adjustable end (10")		X	1
Wrench, Adjustable end (12")		X	1
Wrench, Allen key (hex) (set) set includes sizes numbers 1½-12	X	X	1
Wrench, Open end (set) size ¼-1"	X	X	1

Hand Tools [cont.]	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Wrench, Socket (3/8" drive) (set) 10 piece set, 7 standard sockets; 3/8"-3/4" by 16ths	X	X	1
FABRICATING MACHINES			
Buffer, Pedestal	X	X	1
Compressor, Air 120 p.s.i.; motor 1½ HP; 3-phase; 208 or 220 V; 60 gallon tank	X	X	1
Drill, Electric, Portable (3/8")	X	X	1
Drill, Electric, Portable (¼")	X	X	1
Feeder, E-Z, Self feeding, 3 speeds forward and back, V belt drive, 110 volt and 4 rubber feeder rolls.	X	X	1
Grinder; Edge tool (bench) 1" x 7" model including one fine grit and one coarse grit wheel; motor ½HP; 60-cycle; 110V with overload protection	X	X	1
Grinder, Oil Tool floor model 2-1½"x6" oilstone; wheel, one coarse and one fine grit; ½"x8" emery wheel; ¼HP; 110V; 60-cycle	X	X	1
Jointer (8") long bed; floor model; motor ½HP; 60-cycle; 3-phase; 208V or 220V; with magnetic switch and overload protection	X	X	1
Lathe, Wood turning 12" swing, minimum 38" between center; motor ¾ HP; 60-cycle; 208V or 220V; 3-phase; with mounted switch and overload protection; to include cup center, spur center, 3 face plates, one 6" tool rest, 1 tool support base, 1 knock-out base	X	X	3
Plane, Portable, Electric (16")	X	X	1

EQUIPMENT AND FURNITURE LIST

HAND TOOLS	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Press, Drill (15") 15" capacity; variable speed; number 2 Morse taper in spindle; floor model; ½" key chuck; tilting standard table; with ½HP, 3-phase motor, and magnetic switch and starter	X	X	1
Press, Trio, 12 ton capacity hydraulic jack, heated platens, 110 volts, jack or press guage, assorted dies and plungers.	X	X	1
Press, Veneering and Laminating, air power operated, 20,000 lbs clamping force, for flat or curved work, uses bladder for clamping force, portable.	X	X	1
Router, Portable, Electric ½ or 7/8HP motor	X	X	1
Router/Shaper, overarm. Universal motor develops 2 h.p., 14" x 18" table with miter slot, head travels vertically, table fence halves independentaly, and adjustable front to rear, 230 volt.		X	1
Sander, Belt, Portable, Electric 3" x 24" or 4" x 24", 115V AC	X	X	1
Sander, Combination belt and disc 6" belt; 12" disc, floor model; motor 1 HP, 50-cycle, 208V or 220V; 3-phase; magnetic switch and starter	X	X	1
Sander, Finishing, Portable Electric (heavy duty)	X	X	1
Sander, Handblock stroke 6" belt with sock cap, 4" thick, 60" L; motor 1 HP; 3-phase; 60-cycle; 208 or 220V with magnetic switch and starter	X	X	1
Sander, Spindle 19" oscellating abrasive sleeves; floor stand; motor ½Hp, 3-phase 208 or 220v with magnetic switch and starter	X	X	1

Hand Tools [cont.]	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Saw, Band, Woodcutting 14" floor model; motor ½ HP, 60-cycle, 208v or 220v, 3-phase with magnetic switch and starter or 20" model, motor 1½HP.	X	X	1
Saw, circle, portable power, 4½" dia., blade, motor amps 4.5, length 10½", 5/8" dia., arbor hole.		X	1
Saw, Circular, Power 10" floor model with motor 1½HP, 60-cycle, 208V or 220V, 3-phase with magnetic switch and starter or 12" model, motor 5HP	X	X	1
Saw, Jig (scroll) 24"; metal stand; motor ⅓HP, 60-cycle AC, 115V with magnetic switch and starter	X	X	1
Saw, Radial-arm, Power 10" saw complete with stand, table extensions; motor totally enclosed and fan cooled; motor 2HP, 60-cycle, 208V or 220V, 3-phase; with magnetic switch and starter	X	X	1
Saw, Sabre (bayonet) portable; heavy duty	X	X	1
Shaper, Spindle (floor model) complete with interchangeable spindles 5/16", 1/2", 3/4", and 1" adjustable fence, hold down guides and fence guard assembly; motor 1HP, 50-cycle, 208V or 220V, 3-phase, including reversible switch and overload protection		X	1
Surfacer (single surface planer) 12" x 5" cap; floor model; motor 3HP, 50-cycle, 208V or 220V, 3-phase with magnetic switch and starter and overload protection; or 18" or 20" cap; floor model; motor 5HP, 60-cycle, 208V or 220V with switch and overload protection	X	X	1

EQUIPMENT AND FURNITURE LIST

HAND TOOLS	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Uniplane. 6" width cutting capacity, depth 1/8", 8 cutters, miter slot on table, ¾ h.p., 3 phase motor, 220 volts.		X	1
Welder, Electronic Glue Penetrates 2" of wood, 4 tubes, portable, 115 volts, 18 amps., 13' coax. cables, lighweight hand gun.		X	1
GENERAL FURNISHINGS			
Bench, Demonstration 1¾" x 28" x 60" table top	X	X	1
Bench, Woodworking (2 place) 2¼" x 28½" x 64"; hard maple top; wood or metal; base units 36" W x 21" D, overall bench height 33¼" with 2 vises	X	X	8
Bench, Woodworking (4 place) 2¼" x 54" x 64"; mounted on two 36"W x 21"D x 31"H base units of wood or metal; hard maple top; with 4 vises	X	X	2
Bookcase aprox. 60"H x 10" to 12"D 72"L; 3 adjustable shelves, wood or metal	X	X	2
Cabinet, Filing 4 drawers; 52"H x 15"W x 28½"D	X	X	2
Cabinet, Finishing (storage) steel construction, adjustable shelves, 2 doors with locks	X	X	1
Cabinet, Machine accessory 36"W x 21"D x 31"H, wood or metal; 2¼" x 22" x 54", maple top	X	X	1
Cabinet, Nail and screw storage 22½"H x 48"; see-through plastic drawers	X	X	1
Cabinet, Storage 32W x 22"D x 84"H; 7 shelves; wood or metal construction	X	X	1
Cabinet, Tool storage approx. 62" x 22"D x 84" H	X	X	1
Chair, Teacher's welded steel construction, swivel, with casters	X	X	1
Compressor, Air 120 p.s.i., 1½HP, 208V motor; 60 gallon tank	X	X	1
Desk, Teacher's 42" x 30" x 29"H, welded steel construction	X	X	1
Drying Chamber, 3'x3'x8', 220 volt heating element, circulating fan, automatic control system.	X	X	1
Dust Collection System	X	X	1
Extension Cord heavy duty; grounded, 25'	X	X	2
Fans, Portable, 110 volt, 14" blade, guarded fan blade area, 4" rubber wheels, 12' cord	X	X	2
Fire Blanket	X	X	1
Fire Extinguisher	X	X	3
First Aid Kit	X	X	1
Granulator, 4" wide rotary cutters, feeding rate 20-40 lbs/hr, portable, 220 volt, equipped with mercury breaker switch to cut motor for safety.	X	X	1
Pencil Sharpener, Standard	X	X	1
Projector, Filmstrip (35mm) and slide (2" x 2")	X	X	1
Projector, Motion picture, Sound	X	X	1
Projector, Overhead	X	X	1

EQUIPMENT AND FURNITURE LIST

HAND TOOLS	Introductory Levels I & II	Advanced Levels III & IV	Quantity
Rack, Glue Clamp 72" x 36" x 32"H	X	X	1
Rack, Roll, Wrapping paper (24")	X	X	1
Refrigerator, 110 volt, self defrosting, storage area 18" deep, 22" wide and 3' long.	X	X	1
Screen, Projection 60" x 60"	X	X	1
Spray Booth, Dry approx. size 5'W x 7'H x 4" working depth, with fire deflective curtain and paint arrestor filter cells	X	X	1
Stock Carts, 3 shelves 20" wide, 3½' long and 3' high, 4" rubber wheels.	X	X	3
Table, Drafting overall size approx. 38" x 28" x 39"H, wood or metal or overall size approx. 38½" x 48" x 29"H, wood or metal	X	X	1
Table, Overhead projector	X	X	1
Table, Finishing 1¼" x 24" x 50"; ply wood top, covered with 20 ga. galvanized steel	X	X	1
Table, Spraying top size 50" diameter; with lazy susan; bearing attached to outside	X	X	1
Tank, PEG, 220 volt heating element, thermodisc, safety switch and power panel, 2' x 2' x 4' long fiberglassed box with lid and pilot light.	X	X	1
Testing Machine, Universal, 20,000 lbs. cap., hand hydraulic load application, ram travel 4½", with accessories for testing.	X	X	1
Tumbler with rubber drums, six lb. cap., 110 volt motor.	X	X	1
Vacuum, portable 28 gal. fibre drum cap., hose and nozzle, 110 volt motor.	X	X	2
Wood Impregnation (WPC) Unit. Impregnation vessel, surge tanks, monomer charge, vacuum pump, line, guage and gate assemblies.		X	1
Wood Study Center. Microscope, 10x and 43x power lens, scope light, scope-aid screen, concave mirror, assortment of slides.	X	X	1
EXPERIMENTAL AND RESEARCH EQUIPMENT			
Hot Plate, Electric (100V)		X	1
Meter, Moisture content (electric)	X	X	1
Microscope 10x Hygenian eyepiece with pointer, triple revolving nose-pieces; 3 standard objectives; 4x, 10x, 43x; plain stage with side clips; fixed in stage condensor; iris diaphragm; in base illuminator	X	X	1
Oven 12'W x 10"H x 10"D; 220V, 3-phase or 110V, single-phase	X	X	1
Press, Hydraulic, Heated platen minimun cap. 12 tons; with 12" x 12" platen		X	1
Scale, Household cap. approx. 5 lbs.		X	1
Scale, Laboratory precision accuracy; maximum 1600 grams	X	X	1

Polyethylene Glycol (PEG)
Soaking Schedule

Name_____ Date_____ Sheet No. 1 of 2

Item & No.				
Species				
Size				
Defects green Condition				
% of mixture				
Solution temp.				
Immersed in Solution				
Removed from Solution				
Total soaking time				
Green Wt.				
Soaked wt. (air dry 30 min.) & date				
Eqmc. & date				
Total wt. loss				

Comments

Polyethylene Glycol (PEG)
Drying Schedule

Sheet No. 2 of 2

Name					
Item & No.					
sequence used					
Drying: Date, wt. & temp.					
Removed from drying sequence, date & wt.					
Machining dates					

Comments

AUTOMATIC DRYING CHAMBER
DRYING RECORD

STUDENT NAME	ARTICLE	DATE & TIME	ADHESIVE, PEG, WPC, FINISH, etc.	THERMOSTAT SETTING	HIGH HEAT	LOW HEAT	AVERAGE HEAT	TIME LAPSE (up)	TIME LAPSE (down)	SEQUENCE SELECTED & COMMENTS
*James, O.	Processed WPC woods	5/14/73 11:00am	Polymerizing WPC woods	185°F.	177°F.	163°F.	170°F.	13min.	11min.	#1. Dry for 4 hours.
*Ware, C.	PEG treated wood	6/16/73 9:00am	Drying PEG woods	142°F.	144°F.	129°F.	136°F.	6min.	16min.	#1. Dry for 3 days.
*Tate, O.	Fiberglass re-curve bow	7/6/73 1:00pm	Epoxy Adhesive	180°F.	173°F.	159°F.	166°F.	17min.	12min.	#1 Dry for 2½ hours.

*Samples

Wood Plastic Composition (WPC)

Name_____ Date_____ Sheet No._____

Batch or "run"_____ Treatment Chamber Size_____

Monomer_____ Catalyst_____ Percentage_____

# of Sample	Species	Size		Weight (grams)				Comments
		Dimen.	Cu. In.	Before Trt.	After Trt.	Incr.	% of Incr.	
TOTALS								

Monomer _____gallons, and/or _____pints, _____grams, _____ cu. in.
Catalyst _____grams
Dye _____grams, _____color
Vacuum time_____start, _____finish
Pressure _____pounds
Soaking time_____start, _____finish
Heat _____degrees F.,_____time

NOTE: % of increase in weight is found by dividing amount of increase by original weight.

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Missouri
State
Department
of Education

"Change should be appreciated and made welcome, not avoided or resented. As Americans, we've benefited enormously from it. Today, change is rampant and nowhere is it more evident than in the field of education. We can no longer think in traditional terms. Tomorrow and for many years to come, education must recognize the "career" concept which included all areas and all levels of career preparation."

Arthur L. Mallory
Commissioner of Education